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A STUDY OF THE FERTILIZER REQUIREMENTS OF ALBERTA PEATS FOR BARLEY PRODUCTION

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A STUDY OF THE FERTILIZER REQUIREMENTS OF ALBERTA PEATS FOR BARLEY PRODUCTION

C. F. Bentley

INTRODUCTION

Estimations of the area of peat soil in Alberta range from 10 to 25 million acres; the first figure is a conservative one and it is thought by some that the second one is not extravagant. For the most part this peat is in the gray wooded soil zone. Peat soils, therefore, cover between 1/15 and 1/6 of the area of Alberta and most of them are in the north and northwestern part of the province. In Saskatchewan, where conditions are much the same as in Alberta, it is estimated that there are about 12 million acres of peat soils --again most of it is in the gray soil zone.

Most of the better lands of the prairie provinces are now taken up. Increasing population is seeking new areas to farm. Although part of this population increase is natural it is not improbable that there will be new immigration to Canada after the present war and it is highly probable that there will be government-sponsored settlement schemes following post-war demobilization of the armed forces. As the years go

by it is evident that a larger and larger proportion of the short grass plains of Western Canada is unsuited for straight cereal production, the chief type of agriculture which has been attempted there. A gradual depopulation of this part of the prairies is taking place and is increasing the need for new areas suited to farming. Indications are that as time goes on the pressure of this demand for new farming areas is going to increase.

To-day two very different types of solution appear for this problem in Alberta. They occur in widely separated parts of the province. In southern Alberta expansion of irrigation would provide suitable farm land for a great number of people. In the northern and northwestern part of the province there are vast areas of gray wooded soil which could be used. There are many who believe expansion of Alberta's irrigated area is the wiser solution for this land problem. There are as many championing the case for use of the gray wooded areas. The ultimate course of agricultural expansion will probably be a combination of increased irrigation and further settlement of gray wooded soils.

Since peat lands are for the most part in the gray wooded soil zone they will probably become of increasing importance with further agricultural expansion and development in Alberta and the other prairie provinces. Any land policy here should, therefore, consider what, if any, agricultural use can be made of these peat soils. A study with this object in view has been started.

REVIEW OF LITERATURE

Peat land has been used agriculturally for many decades. Haanel (10) in a chapter entitled "Agricultural uses of peat and peat land" gives general information and history about this subject. In Europe considerable work has been done on the reclamation of peat areas for agricultural use. By 1920 approximately 10% of Germany's 5 million acres of peat land had been reclaimed and converted into farm land. In Sweden, Denmark, Holland, Austria, Russia, Finland and Great Britain hundreds of thousands of acres of peat land have been reclaimed and are now farmed; this reclamation has, to a large extent, been a result of work by government supported experimental stations. In several of these countries legislation has been passed which requires any commercial or industrial uses of peat lands to be carried on in such a fashion as to leave the area suitable for agricultural use or for afforestation. In the United States large areas of peat lands have been drained with a view to reclamation. In Florida much fruit and vegetables is now grown on what was formerly part of the waste land of the Everglades. The peat lands of Michigan and Minnesota are similar to ours although the climate there is moister than it is in Alberta. The crops grown on peat in these two states include cranberries, blueberries, lettuc, cabbage, onions, celery, spinach, kale, cauliflower, sweet corn, potatoes, sugar beets, hay crops,

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oats, barley, rye and wheat. In Michigan truck gardening is extensive on peat land.

Haanel (10) states that to determine what mineral fertilizers are needed an analysis of the peat concerned is advisable as variability is great from one bog to another--even from one place to another in a single field. The substances most frequently required are, in order of need, potassium, phosphorus and lime. Peat soils are largely organic matter and when they are slowly mineralized annual applications of fertilizer are needed to replace a part of the elements removed with crops.

Haanel gives analyses of European peats by various authorities. Thirty-two samples show a nitrogen content ranging from 0.80 to 2.84%, the average being 1.70%. Canadian peats have on the average a high nitrogen content--from 1.0 to 2.8% although percentages as low as 0.46% have been reported by Walker (29).

In reclaiming an area of peat land the first consideration is drainage. Rainfall of the area and the crops to be grown are the chief factors in determining whether a bog should be completely or only partly drained. Alway (3) reports that in certain Minnesota areas it has been found that highest yields are obtained where drainage has not been to more than 20 - 40 inches. Dachnowski (6) lists the chief hazards in use of peat lands as follows: differences between peat lands in their distinctive structural framework; lack of proper control of moisture supply; accumulation of excessive amounts of soluble

salts from the mineral subsoil in the root zone of crops. He points out too that a well-considered program of selection is important in stabilizing and making permanent the agricultural use of peat lands. Lyon and Buckman (15) state that the amount of hygroscopic water in soil rises rapidly with increase in soil organic matter. They say that in mineral soils it varies from a low figure in sandy soil to as high as 18 or 20% in clay soil rich in organic matter. They state that peat soils may have as high as 60 or 70% hygroscopic water. Peat soils at optimum moisture will, therefore, be wetter than mineral soils at optimum moisture.

Ogg and Macleod (20) describe work done on the reclamation and cultivation of peat land on the Island of Lewis. They state that the work done has shown it is possible to successfully reclaim a very barren type of peat land which is widespread in Scotland. For reclamation of peat land they recommend as the first step establishment of pasture to facilitate drainage and humification of the peat; subsequent cultivation will then be easier if it is desired to convert part or all of the area to arable land. They give the cost per acre of converting the moorland of the island into reasonably good pasture and they also give the cost per acre of converting it into cultivated land with the necessary initial applications of minerals and fertilizers. The crops that were grown on cultivated peat land were: oats, marrow-stem kale, potatoes, carrots, cabbages, leeks, celery, onions and parsley; all of these crops did well.

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Ogg (19), while discussing peat land reclamation, states that moss peats are usually very deficient in phosphorus and potassium and says that deficiencies in minor plant foods are possible too. He says that reclaimed peat land is used very satisfactorily in Britain for production of numerous horticultural crops. He points out that summer frosts frequently damage crops susceptible to frost injury when they are grown on peat land; several other authors have mentioned this (1, 10, 12, 32).

Robertson (21) states that potassium in peat soils is almost completely soluble in water. In spite of this great solubility he says only small amounts are washed out in drainage water. He points out that, since a crop may remove as much as 50% of the total potassium present, fairly good yields may be obtained the first year from a peat very low in total potassium. If potassium fertilizers are not added to such peats a marked potassium deficiency will become increasingly obvious as time goes on. He says that surface layers of acid peat soils contain considerably greater numbers of bacteria than the lower layers. He found that nitrifying bacteria were absent both in the surface and lower layers but that they appeared in the surface layer of cultivated soil that was given moderate dressings of lime. He says that heavy lime applications result in enormous increases in the numbers of denitrifying bacteria, which are present in both upper and lower layers of peats, and that harmful effects will result from the changes brought about by these bacteria.

Alway (2), reporting some experimental work with Minnesota peats, found phosphorus the most necessary mineral fertilizer. Potassium fertilizers gave no positive results though he foresaw need for them if crops other than hay for pasture were grown. He recommended as cereal crops to grow on peat the following: flax, oats, winter rye and field peas. Hays recommended were: a mixture of alsike and red clover with timothy; brome grass. He suggests a light application of farmyard manure at the time of breaking peat land as this has been found to hasten decomposition of the organic matter of the peat soil.

Others have experimented with farmyard manure as an aid to peat decomposition and fertilization. Vandecaveye (25) reports addition of manure to a virgin peat increased carbon dioxide evolution as well as numbers of the various groups of microorganisms--except cellulose decomposers and azotobacter; the accumulation of nitrates was also increased. Wheat straw with sufficient sodium nitrate to give it a nitrogen content equal to that of the manure produced the same results. He suggests that this beneficial result on microbiological activities is due to these substances supplying readily available carbon and nitrogen compounds. He found superphosphate and sodium nitrate to have no marked effect on microbiological activities. Lime greatly stimulated carbon dioxide evolution; it caused an increase in the percentage of readily available carbon compounds in the organic matter of peat.

Robinson (22) states that farmyard manure composted with one-third of its weight of peat containing 2% of nitrogen has its fertilizing value approximately doubled; nitrification is greatly accelerated and nitrogen in more or less inert forms is made more readily available than when these materials are used separately.

Waksman and Stevens (28) studying bacteria and other microorganisms in peat soils report findings similar to those of Vandecaveye (25). They say that inorganic nitrogen and phosphorus salts had practically no effect on the rapidity of decomposition of low and high moor peat soils because neither nitrogen nor phosphorus but available energy is the limiting factor in decomposition of peat material. Waksman and Purvis (26) also report that the rate of decomposition of peat is closely correlated with the moisture content. Optimum moisture for decomposition of low moor peat was found to be 50 to 80%. Above and below that optimum the ra te of decomposition diminished rapidly. Drying of peat and then remoistening it greatly stimulated decomposition. There was found to be a slightly higher percentage of nitrogen in the residual peat after decomposition.

Waksman and Purvis (27) report that microorganisms occur throughout the various layers of material making up a peat deposit. These microorganisms--largely bacteria--are chiefly responsible for peat formation and transformation. There are present in low moor peats cellulose decomposing bacteria but in high moor peats they are usually inhibited

by the high hydrogen ion concentration. Due to the fact that cellulose in sphagnum peat is highly resistant to bacterial decomposition this material is but slowly decomposed. Greater numbers of bacteria are found in the more decomposed layers of peat deposits.

Hayes et al (12) report yield results of experiments on Minnesota peat soils over a period of up to twelve years. On the basis of these data they make recommendations as to varieties and types of crops which have been found most suitable. They rate cereals in the following order for decreasing income returns: corn, winter rye, flax, winter wheat, barley, oats and spring wheat. Peatland and other rough awned varieties are the barleys recommended.

Little work has been done on the peats of the prairie provinces of Canada. Ellis (8) states that Manitoba grassland peats of the Rendzina soil zone are ideal for hay production although they are deficient in phosphorus. He says that remarkable increases in hay yields result when phosphate fertilizers are added, and that the phosphorus content of the hay is raised. In Alberta some of the botanical aspects of peats in the vicinity of Edmonton have been studied. Lewis and Dowding (13) report that drier conditions in the area examined are indicated by a tendency of sphagnum to disappear; they found a general tendency towards cessation of peat formation. Growth of other types of vegetation were favored by conditions found at that time. Lewis et al (14) state that the high moor peats are of sphagnum and in general have a pH of from 4.0 to 5.5. Low moor peats of hypnum have a pH of from 5.0 to 6.5.

Members of the Soils Department, University of Alberta, have done some work on Alberta peats. Wyatt and Newton (32) suggest a procedure for reclamation of Alberta peat lands. After drainage of a bog or muskeg it is suggested that the area be pastured while allowing it to settle. Greenfeed is suggested as a first cultivated crop possibly to be followed by other cereals as decomposition and consolidation of the peat takes place. Individual small area trials are recommended to determine the most useful fertilizers; it is suggested that farmyard manure, lime, nitrogen, phosphorus and potassium fertilizers are apt to be beneficial. Bedford (4) reports nitrogen to be a limiting factor in the peats he studied and states that addition of dried blood has very beneficial effects on nitrification in them. He states that carbon dioxide evolution cannot be used alone as an index of the fertility of peat soil. He shows dominant groups of microorganisms in peat and mineral soils to be very different.

Newton (17), doing work on cellulose decomposition, found that nitrogen, potassium and phosphorus individually or collectively had little effect on the rate of cellulose decomposition. He found that with the addition of each essential element (or group of elements) the numbers of ammonifying bacteria in cellulose fermentation cultures increased. Using a number of peats from the Edmonton district he found that the cellulose content varied from zero to 47%. Surface samples had a higher cellulose content than samples from lower layers. He found about twice as much nitrogen in lower layers

as in surface layers. With the addition of an abundant supply of fertilizer salts two peats showed, after incubation, an appreciable loss of cellulose and an increase in bacterial numbers; another peat did not show appreciable differences with the same treatment. Ordinary applications of fertilizers to one peat three to four months before seeding oats did not greatly increase fertility as judged by growth of oat seedlings and by bacterial numbers.

Walker (29) studied 12 peat profiles from the Edmonton district. He found pH values as low as 3.8 in surface samples and found an increase in pH value accompanied an increase in depth in most profiles studied. For the most part there was medium or high nitrogen in high lime (low acidity) samples; lime content usually increased with depth. Total amounts of potassium and phosphorus were rather low while total nitrogen was fairly high; nitrogen content was highest in the more decomposed layers. In a pot culture experiment Walker (30) found applications of inorganic salts had marked effects in some cases on bacterial numbers and nitrate accumulation. Two and one-half tons of lime per acre approximately doubled bacterial numbers and nitrate content; this does not agree with the findings of Robertson (21) already discussed but it is possible that this is due to differences in composition of the peats concerned and/or to differences in their bacterial flora. When applied with fertilizer salts lime had no more effect than salts alone. Newton (16) gives the analyses of some peats in the vicinity of Edmonton and points out that in

some of them total potassium in the surface 2 - 3 feet would be sufficient for only 10 - 15 good grain crops if it were all available to plants. In pot cultures of oats on peat treated with various fertilizers he found that growth of oats was roughly proportional to bacterial numbers, indicating that the fertilizers had an effect on the rate of decomposition. The same fertilizers applied to mineral soils had negligible effects on bacterial numbers. In another pot culture experiment with oats on peat treated with different fertilizers he found that yield was roughly proportional to nitrate accumulation (which was determined three times during the experiment). In a pot culture experiment with a high lime peat fertilizers were found to rank as follows: a complete N+P+K fertilizer was most beneficial, farmyard manure and a combined nitrogen and phosphorus fertilizer were each decidedly beneficial, a combined potassium and phosphorus fertilizer somewhat beneficial, nitrogen alone, phosphorus alone and potassium alone were but slightly beneficial or a ctually harmful, lime was not beneficial. In pot cultures of oats in an acid peat soil results were less consistent and even when lime was applied yields were generally lower. Nitrates accumulated in high lime peat, and in acid peat that had been limed, while growing oats with different fertilizers; this nitrification was of the organic nitrogen of the peat as well as of the inorganic non-nitrate nitrogen of the fertilizers containing that element. In field trials complete N+P+K fertilizers gave the best yields when growing oats for greenfeed. Newton (16) points out that

his findings are at variance with Alway's (1) which showed that high lime Minnesota peats seldom required a nitrogen fertilizer. Alway (1) found nitrogen in low lime peats so slightly available that nitrogen fertilizer was necessary for grains, vegetables and forage crops other than legumes. Carlyle (5) found that application of peat to gray soils in pot cultures was never harmful as measured by bacterial numbers, nitrate accumulation and crop production. Surface and subsurface peats when applied with ammonium phosphate and subsurface peat when applied alone increased bacterial numbers, nitrate accumulation and crop yields.

OUTLINE OF INVESTIGATION

The work reported in this thesis was begun in 1935. The writer himself is responsible only for the work done during 1940 and 1941. The experiments for the previous years were carried out by other members of the Soils Department of the University of Alberta. The plan for each section is included with the section's data because of variations from year to year in plan of experiments as well as in location of them. In general the work which is being reported here can be divided into five parts. These parts are as follows:

1. Field Plot Experiments

Field plot experiments on the fertilizer requirements of peats for barley production have been carried on since 1935. A record of yields with each of the various fertilizer treatments has been kept. Determination of the nitrogen and phosphorus content of the grain has been made in several cases. The detail of each year's experiment is given in the section dealing with the yearly results for field experiments.

2. Pot Culture Experiments

Pot culture experiments, using peat, to study the effects of various trace elements have been carried on since 1938. Oats as well as barley have been used in these experiments and besides yield data there are some results for determination of the potassium and sulphur content of straw from various treatments. The plan of these experiments has

varied from year to year and is given with the data on yearly results.

3. Peat Analyses

Chemical analyses of some of the peat used have been made and tables 29 - 34 give these data.

4. Nitrate Determinations in Field Plots

In 1940 and 1941 monthly determinations of the accumulation of nitrate nitrogen in the fertilized field plots at Stony Plain were made. Similar determinations were made at Duffield in 1941. These data are given in tables 35 and 36.

5. Germination Experiment

As a result of observations made in connection with the pot culture work in 1940 and 1941 an experiment was carried out in 1941 to ascertain whether or not certain fertilizers have an adverse effect on germination of barley seeded in boxes of peat soil. Outline of this experiment is given in table 39.

PROCEDURES AND METHODS

To obtain yields of grain + straw for the field plots either one or two of the central rows of each replicate were harvested, air dried and weighed. By use of a conversion factor this yield was then expressed as pounds per acre. The dried grain bundles were threshed, the grain weighed and by use of another conversion factor grain yield was expressed as bushels per acre. Total nitrogen in the grain was determined by the Gunning-Hibbard modification of the Kjeldahl method as given in the A.O.A.C. (18). Phosphorus in the grain was determined volumetrically after fusion with magnesium nitrate --a modified procedure taken from A.O.A.C. (18).

In the pot culture work the crop for each pot was cut off near the surface and after careful drying was weighed. The grain was then carefully threshed and it too was weighed.

Statistical analysis of data for field plot and pot culture experiments was done using methods given by Snedecor (23) in chapter 10. The formula used to calculate the amount required to give a significant difference between any two treatments in field plots or in pot cultures is from Goulden (9). It follows:

$$\text{Difference required} = \frac{\sqrt{2} \times \sqrt{\text{M.S.E.}} \times t}{\sqrt{\text{number of replicates}}}$$

where M.S.E. is the mean square for error as found by Snedecor's method referred to above,

and t is the value given for that statistic in table 3.8, page 55, Snedecor (23).

Samples for determination of nitrate nitrogen were taken as follows: for the surface layer of 6 2/3 inches a composite of four auger samples from each of the four replicates of each treatment; for the subsurface layer, 6 2/3 to 20 inches, a composite sample of two auger samples from each replicate of each treatment; for the subsoil layer, 20 to 40 inches, a composite of one auger sample from each replicate of each treatment. The determination of nitrate nitrogen was made using Harper's (11) modification of the phenol di-sulfonic acid method for nitrate determination.

The peat analyses were made by standard methods recommended by the A.O.A.C. (18) as a rule. The Gunning-Hibbard modification of the Kjeldahl method was used for the determination of nitrogen. Potassium was precipitated with H_2PtCl_6 from the hot water extracts of ashed samples, and determined gravimetrically. Samples were heated with $MgNO_3$ for total sulphur determinations according to the method given by Swanson and Latshaw (24). Samples of peat soil were fused with Na_2CO_3 for the determination of silica, iron, aluminium, titanium, manganese, phosphorus, calcium and magnesium. Silica was determined gravimetrically by evaporation to dryness with HCl followed by washing and ignition. The ammonia separation method was used to precipitate the iron, aluminium and titanium. Iron and titanium were determined colorimetrically with KCNS and H_2O_2; aluminium was determined by difference. Manganese was precipitated with $(NH_4)_2S_2O_8$ and determined gravimetrically as Mn_3O_4. Calcium was precipitated as CaC_2O_4 and titrated

with standard $KMnO_4$. Magnesium was precipitated as $MgNH_4PO_4$ and determined volumetrically with standard H_2SO_4 and NaOH. Phosphorus was precipitated as $(NH_4)_3PO_4.12MoO_3$ and determined volumetrically with standard NaOH and HNO_3. The pH values were determined colorimetrically and were checked electrometrically.

In the germination experiment and in germination observations of pot culture experiments several counts of the number of seedlings in each pot or box were made. The final counts (the data which are given in tables 37 and 38) were made a few days after the last seedling was observed to come up in each case. In the 1940 pot culture experiment twelve barley seeds were placed in each pot and were covered with the peat; then the fertilizers were applied and finally a very thin layer of peat was put on top of the fertilizer in each pot. In 1941 the twelve seeds of barley in each pot were covered with peat and the fertilizers were then applied; the fertilizers were not covered with peat this time. In both 1940 and 1941 the surface of each pot was lightly moistened after seeding and fertilization were complete.

The germination experiment carried out in boxes was originally intended to compare the effects of two different moisture conditions of the soil as well as the effects of different fertilizers at different rates and with different methods of application. The soil was broken up finely and placed in boxes; the boxes used were strawberry crates (boxes 10 to 24) and tomato crates (boxes 1 to 9 and 25 to 27).

Sufficient distilled water was added to boxes 4 to 6, 10 to 12, 16 to 18 and 22 to 24 to make the soil wet, whereas soil in boxes 1 to 3, 7 to 9, 13 to 15 and 19 to 21 was just moistened. It was intended to maintain this original moisture condition, in each set of boxes, for the duration of the experiment. Unfortunately it was not possible to do this; the excessively hot weather for the period of the experiment (see table 41) made it necessary to add large amounts of water to all boxes to keep them moist at all and to keep the seedlings alive. The total weight of seedlings in each box was obtained by clipping the seedlings off at the surface of the soil and then weighing them.

RESULTS AND DISCUSSION

Field Plot Experiments

Field plot experiments with O.A.C.21 and/or Peatland barley have been carried on since 1935. These field plots were replicated and randomized as shown in table 1 in 1935, 1936 and 1937; in 1938, 1939 and 1940 they were randomized and replicated as shown in table 2. Tables 1 and 3 give the rates at which the various fertilizers were applied in these field experiments. The yearly data from these experiments are given in tables 4 to 16. Tables 17 to 20 summarize these data and give in addition the amount required to give a significant difference between any two treatments where statistical analysis of the yearly data has shown that there are significant differences between treatments. A discussion of each year's results follows.

1. The 1935 Experiments

O.A.C.21 and Peatland barleys were grown on high lime peats near Edmonton and Duffield. Due to a heavy frost August 16th the grain did not fill and was not threshed so that only grain + straw yields were obtainable that year. Notes taken during the summer showed that O.A.C.21 barley headed out a little sooner than Peatland but it was observed that the O.A.C.21 lodged more than the Peatland. Field observations

also noted better growth on both peats with an N+P+K fertilizer.

On the Edmonton peat there were no significant differences between treatments in yield of grain + straw with O.A.C.21 barley (see table 4) but the Peatland with N+P+K fertilizer gave a yield of grain + straw significantly higher than any of the other treatments which did not differ significantly among themselves. Calculation has shown that a difference of 620 pounds between the averages of any two treatments is statistically significant (see the right-hand column, table 17). In total yield for all plots the two barleys were very nearly equal.

At Duffield highly significant results were obtained with both barleys (see table 5). With O.A.C.21 the treatments of N+P and N+P+K were both higher in yield of grain + straw than the other three treatments which did not differ significantly among themselves; the N+P+K treatment was very nearly significantly higher than the N+P treatment. With Peatland barley the N+P+K treatment was significantly higher in yield of grain + straw than any of the others which did not differ significantly among themselves. The Peatland barley gave higher yields than the O.A.C.21 with every one of the five treatments.

2. The 1936 Experiments

These experiments were exactly the same as the 1935 ones.

At Edmonton the Peatland barley ripened earlier and was lodged less. Total yields for all treatments showed that

these two barleys did not differ from each other either in yield of grain + straw or in yield of grain (see table 6). There were no significant differences between treatments in yield of grain + straw or in yield of grain.

At Duffield the fertilizer treatments did not produce significant differences in yield with either barley but there were differences in the composition of the grain (tables 7 and 8). All treatments containing phosphorus increased the percentage phosphorus in the grain; these treatments did not differ from each other in this respect nor did the check and the nitrogen treatments differ significantly. With the O.A.C. 21 barley there was no difference between treatments in nitrogen content of the grain but with Peatland there were differences; the treatments of nitrogen and of N+P gave grain significantly higher in nitrogen--there were no other differences between treatments in this respect.

At Duffield the two barleys were about equal in yield of grain + straw but in yield of grain alone the Peatland was slightly higher.

The summer of 1936 was a dry one and the grain ripened well. As can be seen from the tables, very satisfactory yields were obtained at Duffield.

3. The 1937 Experiments

The experiments were again the same as the 1935 ones.

Drouth in early summer followed by heavy rain in mid-July resulted in the grains on the Edmonton plots being too immature to thresh. There were no significant differences

between treatments on these Edmonton plots (table 9) but the Peatland barley outyielded the O.A.C.21 by a good margin in yield of grain + straw.

At Duffield (table 10) the grain + straw yields show no significant differences between treatments with either barley but the Peatland grain did show significant differences between treatments. The treatments of nitrogen and of N+P both depressed the yield below the other three treatments which did not differ significantly among themselves. There was little, if any, difference between the two barleys in yield of grain + straw but the O.A.C.21 was slightly better in yield of grain.

4. The 1938 Experiments

A new arrangement for the plots was used this year and only Peatland barley was grown (see table 2). At Duffield the only significant difference between treatments was in phosphorus content of grain (see table 11). All treatments containing phosphorus increased the phosphorus content of the grain; there were no other differences in this respect.

At Edmonton all treatments containing nitrogen significantly increased the yield of grain + straw but there were no other significant differences in this respect (see table 12). Grain yields did not differ between treatments. All treatments containing phosphorus increased phosphorus in the grain and all treatments containing nitrogen increased nitrogen in the grain; there were no other differences in these respects.

5. The 1939 Experiments

In 1939 the Edmonton plots were replaced by plots at Stony Plain; the peat was again one high in lime.

At Duffield (see table 13) the treatment of nitrogen alone was replaced by a treatment of N+P+K+B. The check was inferior to the other four treatments in yield of grain + straw while the phosphorus treatment was significantly inferior to the N+P, N+P+K, and N+P+K+B treatments in this respect. In grain yield the check was again significantly inferior to the other four treatments; the N+P treatment was significantly inferior to the remaining three treatments while the N+P+K+B and the N+P+K treatments were significantly superior to all other treatments. In nitrogen content of grain the phosphorus treatment was significantly lower than the others while the check was significantly lower than the N+P+K+B, N+P, and the N+P+K treatments. There were no significant differences between treatments in phosphorus content of grain.

At Stony Plain besides replacing the nitrogen treatment by a treatment of N+P+K+B, the phosphorus treatment was replaced by a treatment of N+P+Na (see table 14). At Stony Plain all treatments gave significantly better yields of grain + straw than the check; there were no other significant differences in this respect. There were no significant differences between treatments in yield of grain and in phosphorus content of grain. In nitrogen content of grain the check was significantly higher than the other treatments other than the N+P one which was significantly higher than the N+P+K treatment

in this respect.

6. The 1940 Experiment

The experiments were the same as in 1939 except that the treatments were the same at both places--at Stony Plain the N+P+Na treatment was replaced by a phosphorus treatment.

At Duffield the crop was very badly lodged and was green when cut. The only significant difference between treatments was in phosphorus content of grain and in yield of grain + straw (see table 15). The treatments of N+P+K and of N+P+K+B were significantly better than the check in yield of grain + straw; the N+P+K+B treatment was significantly better than the N+P+K treatment in this respect. The check was significantly lower than any of the other treatments in phosphorus content of grain; the phosphorus alone gave grain which was significantly higher in phosphorus than that from any of the other treatments.

At Stony Plain (see table 16) the check was significantly lower than the other treatments in yield of grain + straw; the N+P treatment gave a significantly better yield of grain + straw than any of the other treatments. The treatments of N+P+K and N+P were significantly lower than the other treatments in yield of grain.

Although barley has been grown on peat soils in the vicinity of Edmonton for six years only a limited number of definite statements can be made regarding the fertilizer requirements of these peats. Data for yield of grain + straw in 18 replicated experiments where barley was grown on peat

soil with different fertilizers are given; in only 8 of these experiments were there statistically significant differences between treatments although there were several cases where results were very nearly significantly different. However, simple averages for all years for each grain on each peat (see table 17) show that in every case the N+P+K treatment and the N+P+K+B treatment were better than the check in yield of grain + straw; simple averages also show that Peatland barley gave better yields with the N+P treatment than did the check. The N+P+K+B treatment was used only two years and so definite conclusions cannot be drawn regarding it although yields of grain + straw from this treatment were higher than they were from the other treatments in all but one case. The other treatments did not give consistent differences. Hence on the basis of the data presented it would seem that a complete fertilizer is the only one of these treatments which produces a consistent increase in yield of grain + straw. However, with Peatland barley the N+P treatment quite consistently out-yielded the check in yield of grain + straw.

Grain yields for the most part are more variable than yields of grain + straw. The N+P+K treatment in almost all cases gave a better yield of grain than the check (see table 18); this would be expected from the yields of grain + straw. However, the yield of grain on N+P plots was usually lower than on the check; this may have been due to the fertilizer retarding the maturing of the grain or it may be due to it causing a greater growth of coarse straw which resulted in

lower grain yield. On the average the nitrogen treatment and the phosphorus treatments did not increase nor decrease grain yields. The N+P+K treatment (and the N+P+K+B treatment) appears to be the only one which has on the average increased yield of barley grain on these peats.

The fertilizer treatments had marked effects on the nitrogen and phosphorus content of these grains (see tables 19 and 20). In 4 of the 8 sets of results showing percent nitrogen in grain the nitrogen fertilizers produced significant differences in percent nitrogen in the grain, when compared with the check; there is one set of results where, although there is not a statistically significant difference, all treatments containing nitrogen gave grain higher in nitrogen than grain from the check or phosphorus treatment. At Stony Plain in 1939 rather surprising results were obtained--grain from two of the nitrogen treatments was significantly lower in nitrogen than the grain from the check plots. However, on the average fertilizers containing nitrogen have increased the nitrogen content of the grain.

With phosphorus the results are even more striking. Excluding the Stony Plain results and one other result with one fertilizer, every treatment containing phosphorus has produced a statistically significant increase in the phosphorus content of the grain. Grain from Stony Plain plots is on the average considerably higher in phosphorus than grain from other plots; here the fertilizers have not produced significant differences in phosphorus content of grain; this is probably

due to a more plentiful or more available supply of this element in this particular peat soil.

Pot Culture Experiments

Pot culture experiments, with barley and oats, to determine the effects of "trace" elements as fertilizers for peat soils have been carried on since the fall of 1937. Duffield and Stony Plain peats have been used and the experiments have been carried out in one-gallon glazed crocks which have a drainage hole at the base. Table 21 gives the amounts and kinds of fertilizers that have been applied in these pot culture experiments. Four experiments have been carried out. A separate discussion of each of these experiments follows:

1. The 1937 Experiment

In the first experiment (see table 22) Victory oats were grown in the greenhouse in an experiment to determine if sodium sulphate will partly replace potassium sulphate in Stony Plain peat which is low in total potassium. Data for this experiment are given in table 22. Statistical analysis of these data shows that there are highly significant differences for all four types of result given in the table. For grain + straw yields statistical calculation showed that four grams was the difference required to be significant between treatments (see bottom line of table 22). Applying this figure, to the averages for yields of grain + straw, it is found that the N+P+Na and the N+P+K treatments gave signif-

Table 1

Arrangement of barley fertilizer plots on peat fields 1935, 1936, and 1937.

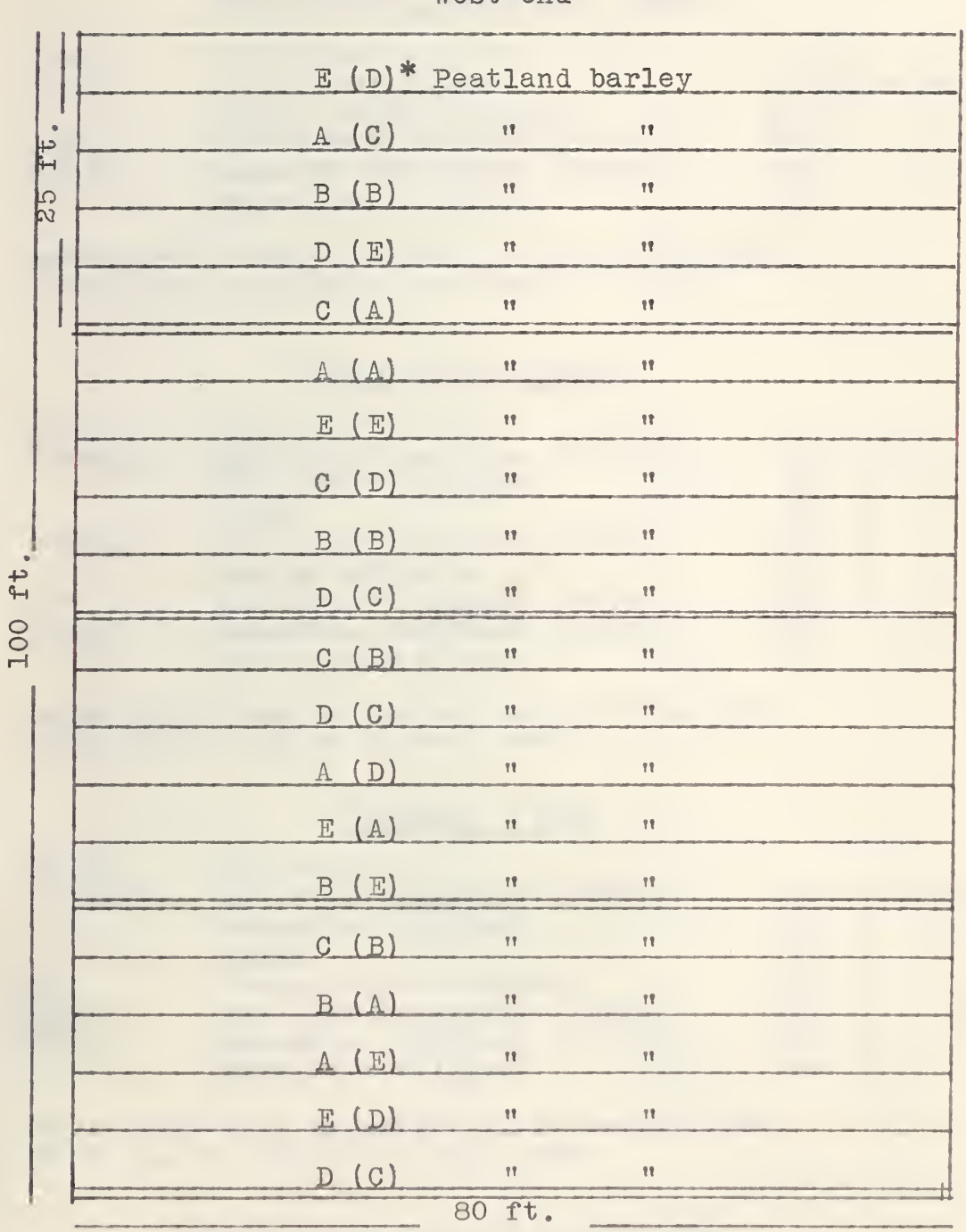
Plot Arrangement

E 1	A 2	B 3	D 4	C 5	O. A. C. 21 barley
E 6	A 7	B 8	D 9	C 10	Peatland barley
A 11	C 12	E 13	D 14	B 15	Peatland barley
A 16	C 17	E 18	D 19	B 20	O. A. C. 21 barley
D 21	B 22	A 23	C 24	E 25	Peatland barley
D 26	B 27	A 28	C 29	E 30	O. A. C. 21 barley
A 31	E 32	C 33	B 34	D 35	O. A. C. 21 barley
A 36	E 37	C 38	B 39	D 40	Peatland barley

Plots		Fertilizers Applied	
A	Check	Untreated	
B	N	Ammonium sulphate	160 lb. per acre
C	P	Triple superphosphate	100 " " "
D	N+P	Ammonium phosphate (16-20)	200 " " "
E	N+P+K	(Ammonium phosphate (16-20)	200 " " ")
		(Potassium sulphate	100 " " ")

Table 2

Arrangement of barley fertilizer plots on peat fields 1938, 1939, and 1940



* This column gives treatment order used on Stony Plain plots.

Table 3

Rates of application of fertilizers for barley plots on peat fields, 1938, 1939 and 1940

Plot		Fertilizers applied	Rates
		Edmonton and Duffield - 1938	
A	Check	Untreated	
B	N	Ammonium sulphate	160 lbs. per acre
C	P	Triple superphosphate	100 " " "
D	N+P	Ammonium phosphate (16-20)	200 " " "
E	N+P+K	Ammonium phosphate (16-20)	200 " " "
		Potassium sulphate	100 " " "
		Seven drill rows of barley in five-foot plot. Fertilizer drilled in with seed.	
		Stony Plain - 1939	
A	Check	Untreated	
B	N+P+K+B	Ammonium phosphate (16-20)	160 lbs. per acre
		Potassium sulphate	80 " " "
		Borax	20 " " "
C	N+P+Na	Ammonium phosphate (16-20)	160 " " "
		Sodium sulphate	80 " " "
D	N+P	Ammonium phosphate (16-20)	170 " " "
E	N+P+K	Ammonium phosphate (16-20)	160 " " "
		Potassium sulphate	80 " " "
		Seven drill rows of barley in five-foot plot. Fertilizer drilled in with seed.	
		Duffield - 1939	
A	Check	Untreated	
B	N+P+K+B	Ammonium phosphate (16-20)	160 lbs. per acre
		Potassium sulphate	80 " " "
		Borax	20 " " "
C	P	Triple superphosphate	170 " " "
D	N+P	Ammonium phosphate (16-20)	160 " " "
E	N+P+K	Ammonium phosphate (16-20)	160 " " "
		Potassium sulphate	80 " " "
		Five drill rows of barley in five-foot plot. Fertiliz er drilled in with seed.	
		Stony Plain and Duffield - 1940	
		Applications and rates exactly the same as for Duffield, 1939.	

Table 4

Yields of O.A.C.21 and Peatland barley on Edmonton peat plots treated with different fertilizers - 1935

Treatment	O.A.C. 21 Plot	O.A.C. 21 Straw & grain in air-dry lbs. per acre	Peatland Plot	Peatland Straw & grain in air-dry lbs. per acre
Check	A 2	7041	A 7	5973
"	A 16	6379	A 11	6562
"	A 28	6387	A 23	7530
"	A 31		A 36	7839
Av.		6602		6976
N	B 3	6815	B 8	6540
"	B 20	7072	B 15	6823
"	B 27	6178	B 22	6845
"	B 34	6257	B 39	7194
Av.		6580		6850
P	C 5	6095	C 10	6191
"	C 17	5978	C 12	5973
"	C 29	6409	C 24	8110
"	C 33	5886	C 38	6723
Av.		6092		6749
N+P	D 4	6714	D 9	6457
"	D 19	5472	D 14	6832
"	D 26	5690	D 21	7443
"	D 35	6998	D 40	6793
Av.		6218		6881
N+P+K	E 1	5712	E 6	7578
"	E 18	6353	E 13	7150
"	E 30	6976	E 25	8580
"	E 32	7107	E 37	7870
Av.		6537		7794

Table 5

Yields of O.A.C.21 and Peatland barley on Duffield peat plots treated with different fertilizers - 1935

Treatment	O.A.C.21 Plot	O.A.C.21 Straw & grain in air-dry lbs. per acre	Peatland Plot	Peatland Straw & grain in air-dry lbs. per acre
Check	A 2	2507	A 7	2564
"	A 16	1897	A 11	3641
"	A 28	3048	A 23	4085
"	A 31	3536	A 36	4055
Av.		2747		3586
N	B 3	2141	B 8	2463
"	B 20	2660	B 15	3475
"	B 27	2529	B 22	3532
"	B 34	3479	B 39	4186
Av.		2702		3414
P	C 5	1639	C 10	2594
"	C 17	2681	C 12	3466
"	C 29	3043	C 24	3205
"	C 33	2542	C 38	3815
Av.		2476		3270
N+P	D 4	2585	D 9	2987
"	D 19	3510	D 14	4107
"	D 26	3837	D 21	4002
"	D 35	3553	D 40	3989
Av.		3371		3771
N+P+K	E 1	3815	E 6	4874
"	E 18	4133	E 13	4120
"	E 30	3488	E 25	5036
"	E 32	4251	E 37	5145
Av.		3922		4794

Table 6

Yields of O.A.C.21 and Peatland barley on Edmonton peat plots treated with different fertilizers - 1936

Treatment	O.A.C.21 Plot	O.A.C.21 Straw & grain Air-dry lbs. per acre	O.A.C.21 Grain Air-dry bus. per acre	Peatland Plot	Peatland Straw & grain Air-dry lbs. per acre	Peatland Grain Air-dry bus. per acre
Check	A 2	9510	5.2	A 7	7580	11.1
"	A 16	6680	13.4	A 11	8500	15.6
"	A 28	8100	16.3	A 23	7570	10.5
"	A 31	7690	23.8	A 36	9810	19.3
Av.		7995	14.7		8365	14.1
N	B 3	6290	5.3	B 8	8910	15.2
"	B 20	9300	12.4	B 15	8160	9.5
"	B 27	9280	21.9	B 22	6480	3.1
"	B 34	9580	25.1	B 39	8810	6.7
Av.		8612	16.2		8090	8.6
P	C 5	8110	12.3	C 10	8240	13.6
"	C 17	7020	4.7	C 12	8250	13.7
"	C 29	7840	9.3	C 24	8230	22.2
"	C 33	11700	25.0	C 38	8600	12.5
Av.		8667	12.8		8330	15.5
N+P	D 4	7080	4.0	D 9	8430	10.9
"	D 19	8720	8.4	D 14	9180	9.6
"	D 26	8500	24.3	D 21	7640	9.3
"	D 35	10600	19.0	D 40	10150	12.1
Av.		8725	13.9		8850	10.5
N+P+K	E 1	7030	7.7	E 6	8390	14.8
"	E 18	10020	16.1	E 13	8600	10.9
"	E 30	8880	13.9	E 25	8240	15.5
"	E 32	10710	20.8	E 37	9770	18.9
Av.		9160	14.6		8750	15.0

Table 7

Yield and composition of Peatland barley on Duffield peat plots treated with different fertilizers, 1936

Plot	Treatment	Straw & grain	Grain			
		Air-dry lb. per acre	Air-dry bus.per acre	Moisture in air-dry grain %	N Water-free basis %	P Water-free basis %
A 7	Check	5720	47.6	8.7	2.01	0.40
A 11	"	6340	49.0	8.7	2.05	0.40
A 23	"	5950	45.5	8.2	2.17	0.39
A 36	"	8870	75.2	10.0	2.09	0.41
Av.	"	6720	54.3	8.9	2.08	0.40
B 8	N	6570	54.5	10.0	2.23	0.39
B 15	"	7920	67.0	9.0	2.40	0.38
B 22	"	7210	55.6	8.9	2.34	0.31
B 39	"	7040	54.2	8.8	2.25	0.40
Av.	"	7185	57.8	9.2	2.30	0.37
C 10	P	6370	45.5	9.0	2.10	0.49
C 12	"	5720	50.3	9.1	2.13	0.47
C 24	"	8960	54.7	8.7	2.27	0.46
C 38	"	4860	41.5	8.8	2.07	0.48
Av.	"	6477	48.0	8.9	2.14	0.47
D 9	N+P	7000	59.0	8.9	2.07	0.45
D 14	"	6230	55.2	8.6	2.33	0.48
D 21	"	7520	55.5	8.5	2.66	0.45
D 40	"	7190	50.1	9.3	2.37	0.49
Av.	"	6985	54.9	8.8	2.36	0.47
E 6	N+P+K	7820	46.8	8.5	2.36	0.42
E 13	"	6950	50.7	8.5	2.12	0.48
E 25	"	7540	47.8	8.4	2.28	0.49
E 37	"	7980	68.6	9.2	1.99	0.46
Av.	"	7572	53.5	8.6	2.19	0.46

Table 8

Yield and composition of O.A.C. 21 barley on Duffield peat plots treated with different fertilizers, 1936

Plot	Treatment	Straw & grain	Grain			
		Air-dry lb. per acre	Air-dry bus.per acre	Moisture in air-dry grain %	N Water-free basis %	P Water-free basis %
A 2	Check	4620	41.2	10.7	2.06	0.38
A 16	"	6200	52.8	9.6	2.39	0.30
A 28	"	6160	50.3	10.7	2.48	0.32
A 31	"	6970	60.6	11.0	2.24	0.38
Av.	"	5987	51.2	10.5	2.29	0.34
B 3	N	5780	49.1	10.2	2.09	0.38
B 20	"	6150	48.7	10.9	2.39	0.33
B 27	"	5750	47.4	9.5	2.40	0.40
B 34	"	9060	82.6	11.2	2.55	0.29
Av.		6685	56.9	10.4	2.36	0.35
C 5	P	5570	47.7	11.4	2.00	0.45
C 17	"	6300	45.8	9.6	2.38	0.46
C 29	"	6580	48.8	10.7	2.23	0.48
C 33	"	5840	49.0	11.4	2.26	0.46
Av.	"	6072	47.8	10.8	2.22	0.46
D 4	N+P	5730	49.2	9.2	2.18	0.46
D 19	"	6250	45.3	9.7	2.37	0.44
D 26	"	5620	43.8	10.0	2.47	0.49
D 35	"	4525	35.2	11.3	2.34	0.48
Av.	"	5531	43.4	10.0	2.34	0.47
E 1	N+P+K	5000	36.1	11.3	2.68	0.42
E 18	"	6290	52.0	9.6	2.34	0.50
E 30	"	6450	54.8	9.5	2.29	0.42
E 32	"	6540	55.7	11.4	2.25	0.45
Av.	"	6070	49.6	10.4	2.39	0.45

Table 9

Yields of O.A.C.21 and Peatland barley on Edmonton peat plots treated with different fertilizers - 1937

Treatment	O.A.C. 21 Plot	O.A.C. 21 Straw & grain in air-dry lbs. per acre	Peatland Plot	Peatland Straw & grain in air-dry lbs. per acre
Check	A 2	5480	A 7	6420
"	A 16	4760	A 11	6940
"	A 28	5120	A 23	5930
"	A 31	4370	A 36	7090
Av.		4932		6595
N	B 3	3970	B 8	6460
"	B 20	6460	B 15	6860
"	B 27	5430	B 22	6520
"	B 34	4390	B 39	6800
Av.		5062		6660
P	C 5	6430	C 10	4750
"	C 17	5260	C 12	7770
"	C 29	4830	C 24	5500
"	C 33	4360	C 38	6960
Av.		5220		6245
N+P	D 4	4890	D 9	6240
"	D 19	5260	D 14	7350
"	D 26	3730	D 21	5220
"	D 35	4340	D 40	7870
Av.		4555		6670
N+P+K	E 1	4900	E 6	7570
"	E 18		E 13	7620
"	E 30	5390	E 25	6720
"	E 32	4540	E 37	7900
Av.		4943		7452

Table 10

Yields of O.A.C.21 and Peatland barley on Duffield peat plots treated with different fertilizers - 1937

Treatment	O.A.C.21 Plot	O.A.C.21 Straw & grain Air-dry lbs. per acre	O.A.C.21 Grain Air-dry bus. per acre	Peatland Plot	Peatland Straw & grain Air-dry lbs. per acre	Peatland Grain Air-dry bus. per acre
Check	A 2	5250	36.0	A 7	4990	31.3
"	A 16	6450	40.5	A 11	7870	44.6
"	A 28	6580	26.1	A 23	10450	27.0
"	A 31	7410	57.6	A 36	6080	43.7
Av.		6422	40.0		7347	36.6
N	B 3	5910	32.9	B 8	6580	30.2
"	B 20			B 15	7000	27.5
"	B 27	5620	33.8	B 22	7780	20.1
"	B 34	8000	32.0	B 39	4880	20.7
Av.		6510	32.9		6560	24.6
P	C 5	4670	20.1	C 10	6040	34.7
"	C 17	6580	40.5	C 12	7120	41.9
"	C 29	5820	40.1	C 24		
"	C 33	9100	48.2	C 38	6120	37.8
Av.		6542	37.2		6427	38.1
N+P	D 4	4580	14.7	D 9	5250	20.3
"	D 19			D 14	10960	41.9
"	D 26	5170	33.3	D 21	8570	29.0
"	D 35	8460	42.3	D 40	6280	26.6
Av.		6070	30.1		7765	29.4
N+P+K	E 1	6870	38.3	E 6	6170	32.9
"	E 18			E 13	8300	47.3
"	E 30			E 25		
"	E 32	7580	51.8	E 37	6440	46.4
Av.		7225	45.0		6970	42.2

Table 11

Yield and composition of Peatland barley on Duffield peat plots treated with different fertilizers - 1938.

DUFFIELD

Plot	Treatment	Straw & grain	Grain			
		Air-dry Lb. per acre	Air-dry Bus. per acre	Moisture in air-dry grain %	N Water-free basis %	P Water-free basis %
A2	Check	2350	12.2	8.1	2.94	0.39
A6	"	3430	21.7	7.9	3.09	0.39
A13	"	4890	31.9	7.7	3.00	0.46
A18	"	5530	37.3	7.5	3.01	0.40
Av.	"	4050	25.8	7.8	3.01	0.41
B3	N	3730	20.5	7.8	2.91	0.43
B9	"	4070	29.0	7.3	3.22	0.40
B15	"	5110	35.8	7.4	3.30	0.34
B17	"	4700	32.2	7.3	2.93	0.39
Av.	"	4402	29.4	7.5	3.09	0.39
C5	P	3660	20.9	7.2	2.89	0.50
C8	"	3380	18.9	7.6	3.05	0.56
C11	"	3680	21.3	8.2	2.95	0.57
C16	"	6270	43.5	7.6	3.07	0.44
Av.	"	4247	26.2	7.6	2.99	0.52
D4	N+P	2660	15.9	7.8	2.97	0.50
D10	"	3140	16.5	7.8	2.87	0.51
D12	"	5010	30.4	7.5	3.15	0.52
D20	"	5200	33.0	8.2	3.06	0.49
Av.	"	4003	24.0	7.8	3.01	0.50
E1	N+P+K	4190	28.2	7.4	3.03	0.50
E7	"	4840	32.7	7.8	2.97	0.46
E14	"	4540	26.2	7.6	2.93	0.47
E19	"	6320	40.7	7.7	3.00	0.50
Av.	"	4973	32.0	7.6	2.98	0.48

Table 12

Yield and composition of Peatland barley on Edmonton peat plots treated with different fertilizers - 1938.

EDMONTON

Plot	Treatment	Straw & grain	Grain			
		Air-dry Lb. per acre	Air-dry Bus.per acre	Moisture in air-dry grain %	N Water-free basis %	P Water-free basis %
A2	Check	4320	28.3	7.8	2.97	0.52
A6	"	4020	21.5	8.3	3.19	0.54
A13	"	3680	22.3	7.6	2.99	0.47
A18	"	4180	27.7	7.8	2.95	0.42
Av.	"	4050	25.0	7.9	3.02	0.49
B3	N	6490	33.5	8.1	3.49	0.51
B9	"	5400	26.8	8.2	3.26	0.48
B15	"	6020	32.3	7.7	3.33	0.45
B17	"	6140	39.5	7.7	3.06	0.50
Av.	"	6012	33.0	7.9	3.28	0.49
C5	P	4050	19.3	7.7	3.14	0.61
C8	"	3490	15.3	6.3	3.09	0.53
C11	"	5900	37.4	7.7	2.91	0.51
C16	"	5220	30.4	6.2	3.14	0.59
Av.	"	4665	25.6	7.0	3.07	0.56
D4	N+P	4350	10.1	6.3	3.24	0.57
D10	"	4720	22.5	8.4	3.40	0.59
D12	"	6660	39.5	6.4	3.01	0.53
D20	"	5980	28.3	6.7	3.24	0.54
Av.	"	5427	25.1	7.0	3.22	0.56
E1	N+P+K	6190	37.0	8.2	3.32	0.55
E7	"	6750	36.4	8.2	3.30	0.56
E14	"	6000	33.7	7.4	3.11	0.53
E19	"	5580	32.3	8.0	3.34	0.50
Av.	"	6130	34.9	8.0	3.27	0.54

Table 13

Yield and composition of Peatland barley on Duffield peat plots treated with different fertilizers - 1939.

DUFFIELD

Plot	Treatment	Straw & grain	Grain			
		Air-dry Lb. per acre	Air-dry Bus. per acre	Moisture in air-dry grain %	N Water-free basis %	P Water-free basis %
A2	Check	2720	6.2	9.1	2.75	0.54
A6	"	3070	6.4	9.8	2.72	0.55
A13	"	2770	6.9	10.3	3.04	0.49
A18	"	2870	5.8	8.2	2.87	0.49
Av.	"	2857	6.3	9.3	2.84	0.52
B3	N+P+K+B	5770	21.4	12.3	3.14	0.54
B9	"	4830	14.9	8.7	3.23	0.52
B15	"	4490	16.4	8.4	3.01	0.51
B17	"	4190	13.4	10.2	3.20	0.53
Av.	"	4820	16.5	9.9	3.14	0.52
C5	P	4250	14.4	11.1	3.14	0.58
C8	"	3850	16.2	11.4	2.87	0.56
C11	"	3830	13.4	10.3	2.98	0.57
C16	"	3600	9.1	9.2	3.07	0.58
Av.	"	3882	13.3	10.5	2.76	0.57
D4	N+P	5380	12.3	10.4	3.07	0.54
D10	"	4730	12.0	9.0	3.12	0.53
D12	"	4250	7.1	8.6	3.06	0.53
D20	"	4100	9.4	12.1	3.23	0.56
Av.	"	4615	10.2	10.0	3.12	0.54
E1	N+P+K	5130	16.2	11.3	2.94	0.50
E7	"	4350	14.1	12.0	2.81	0.54
E14	"	4770	15.3	11.5	3.06	0.51
E19	"	4020	13.5	12.1	3.11	0.51
Av.	"	4567	14.8	11.7	2.98	0.51

Table 14

Yield and composition of Peatland barley on Stony Plain peat plots treated with different fertilizers - 1939.

STONY PLAIN

Plot	Treatment	Straw & grain	Grain			
		Air-dry Lb. per acre	Air-dry Bus.per acre	Moisture in air-dry grain %	N Water-free basis %	P Water-free basis %
A5	Check	1240	7.4	9.6	2.46	0.53
A6	"	1180	8.1	10.7	2.48	0.55
A14	"	1700	9.0	9.6	2.82	0.54
A17	"	1210	7.5	10.8	2.48	0.55
Av.	"	1332	8.0	10.2	2.56	0.54
B3	N+P+K+B	2740	17.0	11.1	2.33	0.57
B9	"	2770	4.2	10.2	2.46	0.57
B11	"	3880	25.0	10.0	2.66	0.59
B16	"	2760	16.4	10.8	2.25	0.55
Av.	"	3037	15.6	10.5	2.42	0.57
C2	N+P+Na	2250	16.6	8.2	2.29	0.54
C10	"	2180	16.1	8.9	2.33	0.57
C12	"	4920	35.9	10.2	2.67	0.55
C20	"	2120	15.6	9.6	2.35	0.56
Av.	"	2867	21.0	9.2	2.41	0.55
D1	N+P	2520	18.2	10.1	2.33	0.57
D8	"	2450	16.2	9.8	2.31	0.55
D13	"	4180	21.5	12.9	3.03	0.61
D19	"	2020	2.4	8.2	2.34	0.54
Av.	"	2792	14.6	10.2	2.50	0.57
E4	N+P+K	2300	15.4	9.4	2.20	0.54
E7	"	2770	4.1	7.3	2.20	0.53
E15	"	2790	7.8	8.5	2.32	0.56
E18	"	2320	7.4	9.1	2.35	0.57
Av.	"	2545	8.7	8.6	2.27	0.55

Table 15

Yield and composition of Peatland barley on Duffield peat plots treated with different fertilizers - 1940

(Results from supplementary observation plots of Olli barley and Victory oats are included in this table.)

DUFFIELD

Plot	Treatment	Straw & grain	Grain			
		Air-dry lb. per acre	Air-dry bus.per acre	Moisture in air-dry grain %	N Water-free basis %	P Water-free basis %
A2	Check	6840	20.1	11.0	3.61	0.50
A6	"	6864	40.2	11.3	3.34	0.54
A13	"	6060	41.0	9.0	3.37	0.50
A18	"	7776	50.3	8.8	3.50	0.48
Av.	"	6885	37.9	10.0	3.45	0.50
B3	N+P+K+B	7584	30.2	11.0	3.48	0.56
B9	"	8988	23.0	10.2	3.42	0.59
B15	"	7836	35.1	10.6	3.40	0.58
B17	"	7740	20.9	10.6	3.43	0.56
Av.	"	8037	27.3	10.6	3.43	0.57
C5	P	6936	16.2	10.6	3.31	0.61
C8	"	7584	26.5	10.5	3.39	0.62
C11	"	6696	36.9	9.7	3.34	0.65
C16	"	7188	32.8	10.1	3.16	0.68
Av.	"	7101	28.1	10.2	3.30	0.64
D4	N+P	7056	32.2	10.0	3.52	0.55
D10	"	8172	38.8	10.1	3.29	0.62
D12	"	7320	22.2	9.2	3.56	0.60
D20	"	6900	28.8	9.4	3.69	0.60
Av.	"	7362	30.5	9.7	3.51	0.59
E1	N+P+K	6960	25.7	11.2	3.25	0.56
E7	"	8064	37.5	9.9	3.25	0.58
E14	"	7044	36.4	8.8	3.33	0.57
E19	"	8304	30.3	9.8	3.44	0.57
Av.	"	7593	32.5	9.9	3.32	0.57
Olli barley, untreated		4548	25.8	9.7	1.32	0.44
Victory oats, untreated		7896	83.0	8.9	1.53	0.32

Table 16

Yield and composition of Peatland barley on Stony Plain peat plots treated with different fertilizers - 1940

(Results from supplementary observation plots of Olli barley and Victory oats are included in this table.)

STONY PLAIN

Plot	Treatment	Straw & grain	Grain			
		Air-dry lb. per acre	Air-dry bus.per acre	Moisture in air-dry grain %	N Water-free basis %	P Water-free basis %
A5	Check	2064	14.2	9.3	2.18	0.56
A6	"	1848	11.9	10.0	2.23	0.54
A14	"	2736	15.1	11.2	3.05	0.63
A17	"	1788	11.4	8.3	2.55	0.56
Av.	"	2109	13.1	9.7	2.50	0.57
B3	N+P+K+B	3240	12.0	11.4	2.29	0.56
B9	"	3156	11.2	11.8	2.37	0.56
B11	"	3576	15.6	11.3	2.55	0.60
B16	"	2316	13.6	9.8	2.79	0.59
Av.	"	3072	13.1	11.1	2.50	0.58
C2	P	2760	19.7	12.1	2.20	0.56
C10	"	2580	11.2	10.7	2.32	0.57
C12	"	3588	20.6	9.6	2.73	0.59
C20	"	2124	14.1	9.2	2.44	0.56
Av.	"	2763	16.4	10.4	2.42	0.57
D1	N+P	3384	22.7	10.3	2.28	0.56
D8	"	3306	20.3	10.1	2.22	0.55
D13	"	4272	18.5	10.5	3.22	0.64
D19	"	2808	19.0	11.5	2.45	0.58
Av.	"	3443	20.1	10.6	2.54	0.58
E4	N+P+K	2652	17.5	10.7	2.26	0.56
E7	"	2868	18.6	9.2	2.20	0.56
E15	"	3096	16.0	9.4	3.06	0.65
E18	"	2616	16.9	10.7	2.63	0.59
Av.	"	2808	17.2	10.0	2.54	0.59
Olli barley, untreated		1332	11.1	10.4	2.13	0.48
Victory oats, untreated		2856	22.0	7.4	1.65	0.41

Table 17

Average yields of grain + straw in lbs. per acre for barley grown on peat soils treated with different fertilizers

Year	Place	Variety	Check	N	P	N+P	N+P+K	Required to give significant difference between treatments
1935	Edmonton	O.A.C.21	6602	6580	6092	6218	6537	
1936	"	"	7995	8612	8667	8725	9160	
1937	"	"	4932	5062	5220	4555	4943	
Av.	"	"	6510	6751	6660	6499	6880	
1935	Duffield	O.A.C.21	2747	2702	2476	3371	3922	590
1936	"	"	5987	6685	6072	5531	6070	
1937	"	"	6422	6510	6542	6070	7225	
Av.	"	"	5052	5299	5030	4957	5739	
1935	Edmonton	Peatland	6976	6850	6749	6881	7794	620
1936	"	"	8365	8090	8330	8850	8750	
1937	"	"	6595	6660	6245	6670	7452	
1938	"	"	4050	6012	4665	5427	6130	1070
Av.	"	"	6498	6903	6497	6957	7531	
1935	Duffield	Peatland	3586	3414	3270	3771	4794	675
1936	"	"	6720	7185	6477	6985	7572	
1937	"	"	7347	6560	6427	7765	6970	
1938	"	"	4050	4402	4247	4003	4973	
1939	"	"	2857	N+P+K+B: (4820	3882	4615	4567	464
1940	"	"	6885	(8037	7101	7362	7593	660
Av.	"	"	5241		5234	5750	6078	
1939	Stony Plain	Peatland	1332	N+P+K+B: (3037	N+P+Na: (2867	2792	2545	740
1940	"	"	2109	((3072	P: (2763	3443	2808	313
Av.	"	"	1720	3054		3117	2677	

Table 18

Average yields of grain in bus. per acre for barley grown on peat soils treated with different fertilizers

Year	Place	Variety	Check	N	P	N+P	N+P+K	Required to give significant difference between treatments
1936	Edmonton	O.A.C.21	14.7	16.2	12.8	13.9	14.6	
1936	Duffield	O.A.C.21	51.2	56.9	47.8	43.4	49.6	
1937	"	"	40.0	32.9	37.2	30.1	45.0	
Av.	"	"	45.6	44.9	42.5	36.7	47.3	
1936	Edmonton	Peatland	14.1	8.6	15.5	10.5	15.0	
1938	"	"	25.0	33.0	25.6	25.1	34.9	
Av.	"	"	19.5	20.8	20.5	17.8	24.9	
1936	Duffield	Peatland	54.3	57.8	48.0	54.9	53.5	
1937	"	"	36.6	24.6	37.1	29.4	42.2	6.1
1938	"	"	25.8	29.4	26.2	24.0	32.0	
				N+P+K+B:				
1939	"	"	6.3	(16.5	13.3	10.2	14.8	2.8
1940	"	"	37.9	(27.3	28.1	30.5	32.5	
Av.	"	"	32.2		30.5	31.8	35.0	
				N+P+K+B:	N+P+Na:			
1939	Stony Plain	Peatland	8.0	(15.6	(21.0	14.6	8.7	
				(	P:			
1940	"	"	13.1	(13.1	(16.4	20.1	17.3	3.4
Av.	"	"	10.5	14.3		17.3	13.0	

Table 19

Average percent nitrogen in grain for barley grown on peat soils treated with different fertilizers

Year	Place	Variety	Check	N	P	N+P	N+P+K	Required to give significant difference between treatments
1936	Duffield	O.A.C.21	2.29	2.36	2.22	2.34	2.39	
1938	Edmonton	Peatland	3.02	3.28	3.07	3.22	3.27	.17
1936	Duffield	Peatland	2.08	2.30	2.14	2.36	2.19	.18
1938	"	"	3.01	3.09	2.99	3.01	2.98	
				N+P+K+B:				
1939	"	"	2.84	(3.14	2.76	3.12	2.98	.16
1940	"	"	3.45	(3.43	3.30	3.51	3.32	
				N+P+K+B:	N+P+Na:			
1939	Stony Plain	Peatland	2.56	(2.42	(2.41	2.50	2.27	.12
				(	P:			
1940	"	"	2.50	(2.50	2.42	2.54	2.54	

Table 20

Average percent phosphorus in grain for barley grown on peat soils treated with different fertilizers

Year	Place	Variety	Check	N	P	N+P	N+P+K	Required to give significant difference between treatments
1936	Duffield	O.A.C.21	.34	.35	.46	.47	.45	.06
1938	Edmonton	Peatland	.49	.49	.56	.56	.54	.05
1936	Duffield	Peatland	.40	.37	.47	.47	.46	.04
1938	"	"	.41	.39	.52	.50	.48	.06
				N+P+K+B:				
1939	"	"	.52	(.52	.57	.54	.51	.04
1940	"	"	.50	(.57	.64	.59	.57	.03
				N+P+K+B:	N+P+Na:			
1939	Stony Plain	Peatland	.54	(.57	(.55	.57	.55	
				(	P:			
1940	"	"	.57	(.58	(.57	.58	.59	

icantly higher yields than the check and that the yield with the N+P+K treatment was significantly higher than with the N+P+Na treatment. For grain yields the data show that both the N+P+Na and the N+P+K treatments gave significantly higher yields than the check. The straw from pots treated with N+P and with N+P+Na had a significantly lower potassium content than the straw from checks and the N+P+K treatment; potassium content of straw from the N+P treatment was also significantly lower than that of straw from the N+P+Na treatment. In sulphur content of straw the N+P+Na (Na_2SO_4) treatment is significantly higher than the other three treatments which do not differ among themselves in this respect.

Hence under conditions of this experiment Na_2SO_4 did partly replace K_2SO_4 as a fertilizer for Stony Plain peat which is low in potassium.

2. The 1938 Experiment

In the second pot culture experiment (see tables 23 and 24) Peatland barley was grown in Duffield and Stony Plain peats. Object of the experiment was to determine whether sodium would partly replace potassium in peat which is low in total potassium and to observe the effects of "trace" elements boron, manganese, copper and zinc. Due to insufficient replication of the boron, manganese, copper and zinc treatments, the results obtained with these elements could not be satisfactorily analyzed statistically. However, the data for the first four treatments in each of

these tables have been statistically analyzed. In the Stony Plain pots (table 23) neither the yield of grain + straw nor the yield of grain showed any significant difference with the various fertilizer treatments. However, the treatments did differ significantly in potassium content of the straw; the N+P+Na treatments were significantly lower than the check in potassium content of straw and the N+P+K treatment was very significantly higher than any of the other treatments in this respect.

In the Duffield pots (table 24) significant differences between treatments were general. The treatments of N+P, N+P+Na and N+P+K are all significantly higher than the check for yield of grain + straw; the treatments of N+P+Na and N+P+K are significantly higher than the treatment of N+P for grain + straw yield but they do not differ significantly from each other in this regard. For yield of grain the check is significantly lower than the other three treatments which do not differ significantly from each other for grain yield. The treatments of N+P and N+P+Na gave straw significantly lower in potassium content than the straw for the check and the N+P+K treatments.

Due to the lack of sufficient replication with the treatments of boron, manganese, copper and zinc, little can be said regarding results with these elements; it is obvious that none of these treatments were highly beneficial nor were they highly harmful.

In this experiment, as in the first pot culture

experiment, significant differences in potassium content of straw with different treatments were found and sodium did partly replace potassium in peat low in total potassium.

3. The 1939 Experiment

In 1939 the same pots and soil were used as were used in 1938; the same fertilizers were applied at the same rate but this time Victory oats were grown. Again due to insufficient replication satisfactory statistical analyses could not be made for the treatments of boron, manganese, copper and zinc; none of these treatments had a marked effect on yield. In Stony Plain pots (see table 25) the N+P+K treatment gave yields of grain + straw significantly higher than the other three treatments which did not differ significantly among themselves; this same treatment was also significantly higher than the other three treatments in yield of grain, while the N+P+Na_2SO_4 treatment was significantly better than the check in this respect. The potassium content of straw from the N+P+K treatment was significantly higher than it was for the other three treatments which did not differ significantly with each other. The sulphur content of straw for each treatment is significantly different to the other three treatments in this respect.

In Duffield pots (table 26) significant differences in grain + straw yields were found; the treatment of N+P+K was significantly higher than the other three treatments and the treatment N+P+Na was significantly higher than the check and N+P treatments in this respect. In grain yield the N+P

treatment was significantly lower than the other three treatments which did not differ in this regard. The potassium content of straw from the N+P+K treatment was significantly higher than for any of the other three treatments which did not differ significantly among themselves in this way. In sulphur content of straw the check was significantly lower than the other three treatments while the treatment of N+P+Na_2SO_4 was significantly higher than the other three treatments in this respect.

This experiment had more significant differences than the 1938 one. With the Stony Plain peat the N+P+K treatment gave significant differences in yield of grain + straw, in yield of grain alone and in potassium content of straw; the N+P+Na_2SO_4 treatment gave a better grain yield than the check; sulphur content of the straw differed between all treatments. Results with Duffield peat were the same except that no differences in grain yield were found; the sulphur content of straw did not differ between treatments with N+P and N+P+K, and the N+P+Na treatment gave better yields of grain + straw than the check.

4. The 1940 Experiment

The 1940 pot culture experiment had the same object as the second and third experiments but this time treatments were in triplicate and so statistical analyses were carried out on the data. Very significant differences between pots treated with N+P+K and pots with only trace elements, were found (see tables 27 and 28). No significant differences

between treatments in yield of grain + straw or in yield of grain were found where only trace element fertilizers were used (table 27). However, with Stony Plain peat when N+P+K fertilizer was used as well as trace elements small but significant differences between treatments in yield of grain + straw were found (see table 28). The treatments of N+P+K+Cu and N+P+K+Zn were significantly higher in yield of straw + grain than the treatment of N+P+K+B; the N+P+K+Cu treatment was also significantly higher than the N+P+K+Mn in this respect.

The 1940 experiment shows marked differences, with both peats, between pots with and without an N+P+K fertilizer. Slight differences between treatments of boron, manganese, copper and zinc were established in one peat when these elements were applied with an N+P+K fertilizer.

Pot culture experiments over a period of four years have established a number of things. In pot culture Na_2SO_4 will usually partly replace K_2SO_4; N+P+Na (Na_2SO_4) increases yield of grain + straw although the increases are not as large as with N+P+K (K_2SO_4). The treatment N+P+Na (NaCl) has almost as great an effect as N+P+Na (Na_2SO_4) when used in these pot cultures. Potassium content of straw was usually lower than the check or the N+P+K treatment when N+P or N+P+Na (Na_2SO_4) or N+P+Na (NaCl) were added. The straw from the N+P+Na (Na_2SO_4) treatment was usually higher in sulphur content than the straw from the other treatments. In most pot culture experiments the treatments in order of increasing yield of grain + straw were: check, N+P, N+P+Na (NaCl),

N+P+Na (Na_2SO_4) and N+P+K (K_2SO_4). Grain yields were usually in this order too. In most cases the check was significantly lower than the treatments of N+P, N+P+Na and N+P+K in yield of grain + straw and in yield of grain. With "trace" elements boron, copper, zinc and manganese a slight advantage of N+P+K+Cu over N+P+K+B and N+P+K+Mn was established statistically once; N+P+K+Zn was slightly better than N+P+K+B in this same experiment.

Chemical Analyses of Edmonton and Duffield Peats

Chemical analyses of the Edmonton and Duffield peats on which the field plots were located in 1935 are given in tables 29, 30, 31, 32 and 33. By inspection of table 33 the two peats can easily be compared. The Edmonton peat was more acid in reaction, was considerably higher in sulphur content, was higher in Al_2O_3, Mn_3O_4 and ash, was very slightly higher in magnesium and was perhaps slightly higher in Fe_2O_3. In other respects for which they were analyzed these two peats did not differ appreciably if at all. The surface and subsurface layers of the two peats vary only slightly in composition--the surface layer is higher in calcium and lower in SiO_2, Al_2O_3, ash and possibly potassium. This would seem to indicate that there is little difference between the two layers of these peats in state of decomposition. The soluble salts in the Edmonton peat are, as would be expected from the data in table 33, somewhat higher than they are in the Duffield peat (see table 34).

Table 21

Amounts and kinds of fertilizers applied in pot culture experiments

Quantities applied to each one-gallon crock in 1937, 1938 and 1939:

N+P	2.00 gm.	ammonium phosphate 10-48.
K	1.00 "	potassium sulphate (contains approximately 40% K).
Na	2.00 "	hydrated sodium sulphate (contains approximately 14% Na).
Na	0.75 "	sodium chloride (contains approximately 40% Na).
B	0.05 "	boric acid.
Mn	0.25 "	manganese chloride.
Cu	0.25 "	copper sulphate.
Zn	0.05 "	zinc chloride.

Quantities applied to each one-gallon crock, 1940:

B	0.05 gm.	boric acid
Mn	0.25 "	manganese chloride
Cu	0.25 "	copper sulphate
Zn	0.05 "	zinc chloride
N+P+K	3.00 "	complete, 9-27-9

Table 22

Pot culture experiment with Victory oats to determine if sodium sulphate will partly replace potassium sulphate in potassium deficient Stony Plain peat. (Seeded October 8, 1937. Harvested June 17, 1938).

Treatment	Grain + straw (dry) grams	Grain (dry) grams	Potassium in straw K %	Sulphur in straw S %
Check	8.9	1.0	.36	.17
"	5.7	0.6	.42	.21
"	8.3	1.2	.47	
N + P	10.0	0.6	.08	.29
"	14.2	3.1	.09	.29
"	9.0	2.0	.08	
N + P + Na (Na_2SO_4)	20.5	5.7	.18	.66
" "	20.2	5.4	.19	.59
" "	23.6	7.6	.16	
N + P + K (K_2SO_4)	26.4	6.0	.41	.24
" "	27.7	5.2	.39	.32
" "	26.3	7.4	.37	

Treatment		Average		
Check	7.6	0.9	.42	.19
N + P	11.1	1.9	.08	.29
N+P+Na (Na_2SO_4)	21.4	6.2	.18	.62
N+P+K (K_2SO_4)	26.8	6.2	.39	.28
Amount required to give significant difference between any 2 tests	4.0	1.7	.06	.11

Table 23

Pot culture experiment with Peatland barley to determine effects of "trace" elements, sodium, boron, manganese, copper, and zinc in Stony Plain peat.
(Seeded May 23, 1938. Harvested August 19, 1938).

Treatment	Grain + straw (dry) grams	Grain (dry) grams	Potassium in straw K%
N + P	30.4	14.8	.40
"	31.7	14.3	.37
"	28.9	12.6	
N + P + Na (Na_2SO_4)	28.1	11.7	.28
" "	32.5	14.0	.30
" "	35.4	14.3	
N + P + Na (NaCl)	30.5	12.6	.32
" "	32.6	14.0	.32
" "	35.5	15.4	
N + P + K (K_2SO_4)	32.4	13.2	.81
" "	34.8	14.1	.80
" "	34.4	13.8	
N + P + B	30.7	11.3	
"	30.6	12.6	
N + P + Mn	29.0	10.0	
"	35.3	14.4	
N + P + Cu	33.5	13.8	
N + P + Zn	40.0	18.0	

Treatment		Average	
N + P	30.3	13.9	.38
N+P+Na (Na_2SO_4)	32.0	13.3	.29
N+P+Na (NaCl)	32.9	14.0	.32
N+P+K (K_2SO_4)	33.9	13.7	.80
Amount required to give significant difference between any 2 tests			.04

Table 24

Pot culture experiment with Peatland barley to determine effects of "trace" elements, sodium, boron, manganese, copper, and zinc in Duffield peat. (Seeded May 23, 1938. Harvested August 19, 1938).

Treatment	Grain + straw (dry) grams	Grain (dry) grams	Potassium in straw K%
Check	14.0	5.8	.62
"	11.8	4.7	.70
"	16.0	7.6	
N + P	23.0	9.9	.34
"	28.6	14.5	.23
"	31.7	15.0	
N + P + Na (Na_2SO_4)	36.3	16.3	.22
" "	32.4	15.3	.18
" "	33.8	14.5	
N + P + K (K_2SO_4)	35.4	13.2	.83
" "	33.8	14.9	.69
" "	35.4	15.9	
N + P + B (H_3BO_3)	38.5	17.1	
" "	42.1	18.1	
N + P + Mn ($MnCl_2$)	44.2	18.7	
" "	42.2	19.3	
N + P + Cu ($CuSO_4$)	36.6	16.3	
N + P + Zn ($ZnCl_3$)	41.8	17.8	

Treatment		Average	
Check	13.9	6.0	.66
N + P	27.8	13.1	.28
N+P+Na (Na_2SO_4)	34.2	15.4	.20
N+P+K (K_2SO_4)	34.9	14.7	.76
Amount required to give significant difference between any 2 tests	4.8	3.1	.17

Table 25

Pot culture experiment with Victory oats to determine effects of "trace" elements, sodium, boron, manganese, copper, and zinc in Stony Plain peat. (Seeded January 13, 1939).

Treatment	Date seeded & fertilized	Date harvested	Grain+ straw (dry) grams	Grain (dry) grams	Potassium in straw K%	Sulphur in straw S%
		Second Crop				
N+P	Jan. 13/39	July 6/39	19.2	3.1	0.25	0.63
"	"	"	16.6	1.7	0.20	0.63
"	"	"	12.5	0.9		
N+P+Na (Na_2SO_4)	"	"	18.8	5.2	0.19	0.59
" "	"	"	21.1	5.3	0.20	0.53
" "	"	"	18.7	7.0		
N+P+Na (NaCl)	"	"	21.4	7.8	0.16	0.33
" "	"	"	17.8	2.8	0.24	0.33
" "	"	"	15.3	2.0		
N+P+K (K_2SO_4)	"	June 19/39	34.1	14.4	1.22	0.40
" "	"	"	37.5	14.1	0.96	0.37
" "	"	"	37.4	15.0		
N+P+K+B (H_3BO_3)	"	"	41.3	17.4		
" "	"	"	40.4	14.6		
N+P+K+Mn ($MnSO_4$)	"	"	39.4	14.4		
" "	"	"	39.1	14.9		
N+P+K+Cu ($CuSO_4$)	"	"	38.9	15.3		
N+P+K+Zn ($ZnCl_2$)	"	"	43.0	18.1		

Treatment	Average			
N + P	16.1	1.9	0.22	0.63
N+P+Na (Na_2SO_4)	19.5	5.8	0.19	0.56
N+P+Na (NaCl)	18.2	4.2	0.20	0.33
N+P+K (K_2SO_4)	36.3	14.5	1.09	0.38
Amount required to give significant difference between any 2 tests	4.5	3.1	0.25	0.05

Table 26

Pot culture experiment with Victory oats to determine effects of "trace" elements, sodium, boron, manganese, copper, and zinc in Duffield peat. (Seeded January 13, 1939).

Treatment	Date seeded & fertilized	Date harvested	Grain+ straw (dry) grams	Grain (dry) grams	Potassium in straw K%	Sulphur in straw S%
		Second Crop				
Check	Jan. 13/39	June 13/39	23.8	6.5	0.20	0.11
"	"	"	25.9	7.8	0.21	0.09
"	"	"	25.5	7.4		
N+P	"	June 19/39	26.0	1.6	0.27	0.51
"	"	"	28.1	1.3	0.23	0.63
"	"	"	26.0	1.0		
N+P+Na (Na_2SO_4)	"	June 27/39	39.7	10.4	0.23	0.73
" "	"	"	45.7	7.4	0.19	0.80
" "	"	"	38.9	5.5		
N+P+K (K_2SO_4)	"	June 19/39	57.1	9.2	0.64	0.50
" "	"	"	57.9	7.3	0.64	0.37
" "	"	"	58.5	9.8		
N+P+K+B (H_3BO_3)	"	"	57.8	10.7		
" "	"	"	55.8	11.1		
N+P+K+Mn ($MnSO_4$)	"	"	54.2	14.3		
" "	"	"	54.9	14.8		
N+P+K+Cu ($CuSO_4$)	"	"	52.1	25.0		
N+P+K+Zn ($ZnCl_2$)	"	"	58.2	9.7		

Treatment	Average			
Check	25.1	7.2	0.20	0.10
N + P	26.7	1.3	0.25	0.57
N+P+Na (Na_2SO_4)	41.4	7.8	0.21	0.76
N+P+K (K_2SO_4)	57.8	8.8	0.64	0.43
Amount required to give significant difference between any 2 tests	3.1	2.7	0.05	0.18

Table 27

Pot culture experiment with Peatland barley to determine effects of "trace" elements, boron, manganese, copper, and zinc in Duffield and Stony Plain peat. (Seeded June 4, 1940. Harvested September 24, 1940)

Treatment	Duffield		Stony Plain	
	Grain + straw (water-free) grams	Grain (water-free) grams	Grain + straw (water-free) grams	Grain (water-free) grams
Check	25.0	9.6	6.0	1.6
"	24.0	10.2	6.0	1.9
"	24.8	10.8	5.3	1.2
Av."	24.6	10.2	5.8	1.6
B (H_3BO_3)	26.1	10.8	6.8	1.4
" "	26.1	9.8	3.6	0.7
" "	27.2	11.0	5.7	1.6
Av. "	26.5	10.5	5.4	1.2
Mn ($MnSO_4$)	27.8	11.4	5.4	1.4
" "	29.8	12.8	8.3	2.0
" "	27.9	11.5	5.3	1.1
Av. " "	28.5	11.9	6.3	1.5
Cu ($CuSO_4$)	26.5	11.0	4.3	0.9
" "	31.2	12.5	5.7	1.3
" "	28.0	12.0	10.7	3.1
Av. " "	28.6	11.8	6.9	1.8
Zn ($ZnCl_2$)	28.9	12.1	5.5	1.5
" "	26.8	11.8	6.8	1.3
" "	25.8	10.4	7.0	2.2
Av. " "	27.2	11.4	6.4	1.7

No significant differences between treatments.

Table 28

Pot culture experiment with Peatland barley to determine effects of "trace" elements, boron, manganese, copper, and zinc when applied with a complete (NPK) fertilizer in Duffield and Stony Plain peat. (Seeded June 24, 1940. Harvested September 24, 1940)

Treatment	Duffield		Stony Plain	
	Grain + straw (water-free) grams	Grain (water-free) grams	Grain + straw (water-free) grams	Grain (water-free) grams
N+P+K+B	34.0	12.6	24.4	8.9
"	35.0	12.8	26.1	10.4
"	36.3	15.0	25.8	10.1
Av. "	35.1	13.5	25.4	9.8
N+P+K+Mn	37.0	15.3	27.0	12.6
"	35.2	11.7	27.9	11.3
"	31.6	11.5	25.6	10.3
Av. "	34.6	12.8	26.8	11.4
N+P+K+Cu	34.9	15.3	29.9	11.4
"	36.3	14.1	32.0	12.2
"	33.8	13.5	27.5	12.4
Av. "	35.0	14.3	29.8	12.0
N+P+K+Zn	30.1	12.3	27.2	10.2
"	36.2	14.4	27.8	11.2
"	34.0	12.0	28.8	12.1
Av. "	33.4	12.9	27.9	11.2
Amount required to give significant difference between any two treatments			2.3	

Lewis et al (14), Newton (17) and Walker (29) found hydrogen ion concentrations of peats in the vicinity of Edmonton to vary from about pH 3.8 to 7.5. The majority, however, were within the pH range 5.0 to 6.5. The Edmonton and Duffield peats vary from pH 4.8 to 6.2 and would, therefore, seem to be quite representative of the area in this respect; they also lie near the centre of the pH range found by Dachnowski-Stokes (7)--using peat samples from many parts of the United States he found a pH range of from 3.5 to 7.1. Walker (29) gives data for percentage calcium, phosphorus, nitrogen and potassium in peats from Minnesota, Ottawa and Scotland. Compared with the Edmonton and Stony Plain peats these peats are definitely lower in calcium, have about the same phosphorus content, are slightly lower in nitrogen content and are definitely lower in potassium. In analyses of peats in the vicinity of Edmonton, Bedford (4), Newton (17), and Walker (29) found the percentage nitrogen to be definitely lower than it is in the Edmonton and Duffield peats reported here--few samples were above 2% nitrogen and the average was approximately 1.3% nitrogen. The calcium content of the samples from the vicinity of Edmonton was quite variable--.64 to 6.67% calcium; the Duffield and Edmonton samples reported here are near the average of samples from the vicinity of Edmonton previously analyzed for calcium content. As already stated Haanel (10) gives data for percent nitrogen ranging from .80 to 2.84 in peat samples from various parts of Europe; the average for his 32 samples was 1.7% nitrogen.

From these data it is to be concluded that the Edmonton and Duffield peats whose chemical composition is reported on here have at least an average (if not better than average) supply of some of the commoner essential elements when they are compared with the supply of these elements in other peats.

Nitrate Determinations in Field Plots

Tables 35 and 36 give the results of the nitrate determinations made in the field plots in 1940 and 1941. At Stony Plain there is considerable variability in nitrate content of the different plots each time a determination is made; this variability is not consistent and does not appear to be correlated with the fertilizer treatments. Although only three determinations have been made in the Duffield plots the indications are that the fluctuations in nitrate content are at least as great as at Stony Plain and that there is no correlation between the treatments and the fluctuations.

It is to be noted that there are great differences between these two peats in nitrate content; in the Duffield peat nitrates are generally several times as high as they are in the Stony Plain peat. There are two factors which are probably responsible for this difference. Firstly, the Stony Plain peat is relatively undecomposed sphagnum moss; at Duffield the peat is so well decomposed that the parent material cannot be determined by inspection of a clod of it. Secondly the Duffield peat has a lower moisture content (see tables 35

Table 29

Chemical composition of Duffield peat soils - 1935.

Location	Depth in inches (profile layer)	Character of peat or underlying soil	N %	P %	Ca %	Mg %	K %	pH
Plot B 3	0-10	Dark brown. Coarse & loose	2.07	0.12	4.50	0.58	0.15	6.1
	10-54	Lighter brown. More compact	2.47	0.07	2.14	0.57	0.18	6.0
	54-62	Gray clay	0.11	0.02	0.51	0.79	1.35	7.2
Plot B 15	0-12	Dark brown. Coarse & loose	2.30	0.11	3.02	0.56	0.16	6.0
	12-54	Lighter brown. More compact	2.56	0.07	2.24	0.58	0.13	6.0
	54-66	Gray clay	0.10	0.03	0.47	0.78	1.45	6.7
Plot B 22	0-12	Dark brown, Coarse & loose	2.50	0.10	2.92	0.54	0.19	6.1
	12-48	Lighter brown. More compact	2.50	0.07	1.74	0.44	0.23	5.8
	48-60	Gray clay	0.13	0.03	0.56	0.88	1.35	6.4
Plot B 34	0-12	Dark brown. Coarse & loose	2.80	0.11	3.32	0.53	0.12	6.2
	12-54	Lighter brown. More compact	2.45	0.08	1.90	0.47	0.22	6.1
	54-66	Gray clay	0.13	0.03	0.57	0.71	1.36	6.8

Table 30

Chemical composition of Duffield peat soil - 1936

Location	Depth in inches (profile layer)	Character of peat or underlying soil	S %	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	TiO_2 %	Mn_3O_4 %	Ash %
Plot B 3	0-10	Dark brown. Coarse & loose	0.66	0.94	0.80	0.21	0.03	0.08	10.96
	10-54	Lighter brown. More compact	1.05	10.16	1.83	0.19	0.08	none	17.34
	54-62	Gray clay	0.06	83.27	7.17	2.03	0.36	0.26	94.54
Plot B 15	0-12	Dark brown. Coarse & loose	1.09	1.14	0.88	0.21	0.03	0.09	8.49
	12-54	Lighter brown. More compact	1.24	9.66	2.02	0.27	0.08	0.57	16.62
	54-66	Gray clay	0.26	78.31	11.02	1.97	0.56	0.62	95.33
Plot B 22	0-12	Dark brown. Coarse & loose	0.67	0.63	0.47	0.09	0.03	none	8.18
	12-48	Lighter brown. More compact	1.05	15.43	1.95	0.07	0.11	0.28	21.43
	48-60	Gray clay	0.09	78.38	7.56	5.28	0.57	0.50	95.62
Plot B 34	0-12	Dark brown. Coarse & loose	0.76	1.32	0.52	0.24	0.05	none	9.70
	12-54	Lighter brown. More compact	1.10	8.95	1.05	0.09	0.08	0.22	15.65
	54-66	Gray clay	0.30	79.03	11.79	1.36	0.49	0.48	96.53

Table 31

Chemical composition of Edmonton peat soil - 1935.

Location	Depth in inches (profile layer)	Character of peat or underlying soil	N %	P %	Ca %	Mg %	K %	pH
S.E. corner	0-21	Dark brown. Coarse	2.64	0.07	3.60	0.79	0.14	5.5
	21-44	Darker brown. Finer	2.74	0.07	2.56	0.65	0.12	4.8
	44-54	Gray clay	0.18	0.03	0.85	0.89	1.83	5.1
S.W. corner	0-21	Dark brown. Coarse	2.52	0.08	3.48	0.52	0.16	5.2
	21-44	Darker brown. Finer	2.92	0.07	2.42	0.61	0.15	5.1
	44-54	Gray clay	0.13	0.03	0.90	0.87	1.76	5.1
N.E. corner	0-20	Dark brown. Coarse	2.76	0.08	2.08	0.49	0.09	5.1
	20-36	Darker brown. Finer	2.20	0.07	1.55	0.55	0.39	4.9
	36-50	Gray clay with iron stains	0.18	0.04	0.66	0.94	2.04	5.2
N.W. corner	0-15	Dark brown. Coarse	2.54	0.08	3.02	0.55	0.12	5.5
	15-44	Darker brown. Finer	2.52	0.07	2.16	0.58	0.26	5.0
	44-54	Gray clay with iron stains	0.19	0.05	0.61	0.96	2.60	5.1

Table 32

Chemical composition of Edmonton peat soil - 1936

Location	Depth in inches (profile layer)	Character of peat or underlying soil	S %	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	TiO_2 %	Mn_3O_4 %	Ash %
S.E. corner	0-21	Dark brown. Coarse	3.03	1.32	1.13	0.04	0.02	0.39	12.04
	21-44	Darker brown. Finer	3.13	6.72	2.54	0.40	0.06	0.57	17.87
	44-54	Gray clay	0.24	63.12	21.06	5.86	0.34	0.73	90.56
S.W. corner	0-21	Dark brown. Coarse	2.90	1.39	1.16	0.17	0.02	0.46	11.75
	21-44	Darker brown. Finer	3.31	8.40	2.89	0.73	0.06	0.59	18.40
	44-54	Gray clay	0.20	65.32	21.10	4.11	0.52	0.75	92.83
N.E. corner	0-20	Dark brown. Coarse	2.53	2.63	1.54	0.16	0.02	0.11	12.28
	20-36	Darker brown. Finer	2.56	11.64	1.52	0.69	0.10	0.58	22.39
	36-50	Gray clay with iron stains	0.27	66.82	18.15	4.98	0.35	0.31	93.68
N.W. corner	0-15	Dark brown. Coarse	2.40	3.28	1.26	0.02	0.03	0.13	13.79
	15-44	Darker brown. Finer	2.76	10.80	3.77	0.01	0.09	0.03	21.12
	44-54	Gray clay with iron stains	0.11	64.72	15.93	6.03	0.56	0.11	92.21

Table 33

Summary of the chemical composition of Edmonton and Duffield peat soils (as obtained by averaging results of analysis of four samples of each peat)

Depth in inches		pH	N %	P %	Ca %	Mg %	K %	S %	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	TiO_2 %	Mn_3O_4 %	Ash %
							Edmonton							
0- 2	(peat)	5.4	2.61	.08	3.07	.59	.15	2.71	2.15	1.27	.10	.02	.28	12.46
21-44	(peat)	4.9	2.59	.07	2.17	.60	.23	2.94	9.39	2.68	..46	.08	.44	19.94
44-54	(clay)	5.1	.17	.04	.78	.91	2.06	.23	65.19	19.06	5.24	.44	.47	92.32
							Duffield							
0-10	(peat)	6.1	2.42	.11	3.44	.55	.15	.79	1.01	.68	.19	.03	.04	9.33
10-54	(peat)	6.0	2.49	.07	2.00	.51	.19	1.10	11.05	1.71	.15	.09	.27	17.76
54-62	(clay)	6.8	.12	.03	.53	.79	1.38	.18	79.75	9.38	2.66	.49	.46	95.50

Table 34

Water soluble salts in Duffield and Edmonton peat soils - 1935.

Location	Depth in inches (Profile layer)	Character of peat or underlying soil	Total solids %	Total non-vol. solids %	Ca %	Mg %	CO_3 %	HCO_3 %	Cl %	SO_4 %
				Duffield						
Plot B 22	0-12	Dark brown. Coarse & loose	0.72	0.45	0.09	0.03	0.0	0.09	0.02	0.20
	12-48	Lighter brown. More compact	0.52	0.24	0.08	0.02	0.0	0.05	0.02	0.12
	48-60	Gray clay	0.20	0.06	0.03	0.02	0.0	0.02	0.01	0.02
				Edmonton						
N.E. corner	0-20	Dark brown. Coarse	1.70	1.00	0.33	0.12	0.0	0.08	0.03	0.59
	20-36	Darker brown. Finer	2.04	1.38	0.19	0.06	0.0	0.04	0.02	0.80
	36-50	Gray clay with iron stains	0.34	0.12	0.02	0.01	0.0	0.03	0.01	0.08

and 36). As a consequence, ammonifying and nitrifying bacteria have a much better type of material to work on at Duffield and at the same time conditions there are more favorable for these bacteria than they are in the Stony Plain peat.

Field observations of the barley on these plots in 1941 show that at Duffield the crop is heavier in growth and much later than at Stony Plain. This was also the case in 1940. It is quite probable that the rank growth and slowness to mature of the Duffield plots is due to the high nitrate content of that peat.

Barley Germination Experiment

A chance observation is responsible for these data being reported. In 1940 and 1941 a count of the number of seedlings per pot was made for the pot culture experiments (see tables 37 and 38). Most pots had either 11 or 12 seedlings but an examination of the data for all pots gave the impression that there was a lower percentage germination in pots that had been treated with a complete fertilizer. Calculation of the averages proved this to be correct; statistical analysis showed that the differences were highly significant. Hence under conditions of these pot culture experiments the application of complete N+P+K fertilizer had had a depressing effect on the percentage germination of barley. It is to be noted that this result was obtained when the application of fertilizer was very heavy--1250 pounds per acre.

Table 35

Seasonal fluctuations in nitrate and moisture in Stony Plain barley peat plots treated with different fertilizers, 1940

Plot	Treatment	Date sampled	Depth in ins.	Moisture %	Nitrate-N p.p.m. w.f.basis	Depth in ins.	Moisture %	Nitrate-N p.p.m. w.f.basis	Depth in ins.	Moisture %	Nitrate-N p.p.m. w.f.basis
A,5,6,14,17	Check	June 7	0-6 2/3	421	79	6 2/3-20	469	44			
C2,10,12,20	P	"	"	354	79	"	478	42			
D18,13,19	N+P	"	"	378	79	"	472	45			
E4,7,15,18	N+P+K	"	"	385	77	"	472	37			
A5,6,14,17	Check	July 11	0-6 2/3	364	36	6 2/3-20	423	13	20-40	427	17
C2,10,12,20	P	"	"	407	16	"	403	7	"	367	13
D1,8,13,19	N+P	"	"	345	40	"	453	10	"	374	18
E4,7,15,18	N+P+K	"	"	357	9	"	393	7	"	480	9
A5,6,14,17	Check	Aug. 13	0-6 2/3	325	11	6 2/3-20	404	11	20-40	463	15
C2,10,12,20	P	"	"	315	11	"	382	7	"	306	8
D1,8,13,19	N+P	"	"	304	9	"	362	8	"	389	11
E4,7,15,18	N+P+K	"	"	296	10	"	392	6	"	460	14
A5,6,14,17	Check	Sept.16	0-6 2/3		8	6 2/3-20		5	20-40		5
C2,10,12,20	P	"	"		6	"		4	"		2
D1,8,13,19	N+P	"	"		trace	"		trace	"		5
E4,7,15,18	N+P+K	"	"		5	"		5	"		5
A5,6,14,17	Check	Oct. 14	0-6 2/3	293	17	6 2/3-20	368	8	20-40	398	10
C2,10,12,20	P	"	"	293	17	"	362	5	"	366	8
D1,8,13,10	N+P	"	"	293	14	"	358	6	"	383	6
E4,7,15,18	N+P+K	"	"	298	20	"	368	8	"	389	16

Table 36

Seasonal fluctuations in nitrate and moisture in Stony Plain and Duffield barley peat plots treated with different fertilizers, 1941

Treatment	Date sampled	Depth in inches	Moisture %	Nitrate-N p.p.m. w.f.basis	Depth in inches	Moisture %	Nitrate-N p.p.m. w.f.basis	Depth in inches	Moisture %	Nitrate-N p.p.m. w.f.basis
				Stony Plain						
Check	May 22	0-6 2/3	322	64	6 2/3-20	412	40			
P	"	"	315	65	"	432	27			
N+P	"	"	326	80	"	383	52			
N+P+K	"	"	342	64	"	409	38			
Check	June 30	0-6 2/3	321	45	"	435	19	20-40	473	21
P	"	"	306	56	"	371	32	"	432	18
N+P	"	"	318	51	"	389	21	"	407	15
N+P+K	"	"	326	31	"	377	20	"	476	10
Check	July 25	0-6 2/3	249	35	"	305	17	"	362	56
P	"	"	231	52	"	325	40	"	373	46
N+P	"	"	222	51	"	300	37	"	375	50
N+P+K	"	"	243	42	"	305	31	"	375	47
				Duffield						
Check	May 22	0-6 2/3	121	87	6 2/3-18	122	61			
P	"	"	146	95	"	163	56			
N+P	"	"	160	104	"	192	82			
N+P+K	"	"	122	108	"	114	41	Clay subsoil reached at about 18" depth in this peat.		
Check	June 30	0-6 2/3	221	252	6 2/3-18	226	219			
P	"	"	230	216	"	230	180			
N+P	"	"	209	204	"	235	210			
N+P+K	"	"	213	216	"	245	216			
Check	July 25	0-6 2/3	139	255	6 2/3-18	182	206			
P	"	"	129	230	"	168	200			
N+P	"	"	126	255	"	169	200			
N+P+K	"	"	111	185	"	137	180			

An experiment, the plan of which is given in table 39, was carried out in an endeavor to determine whether or not more practical rates of fertilization would affect the germination of barley in peat soil. The experiment was designed to compare different methods of applying the fertilizer and it was originally intended to compare effects of fertilizers under different moisture conditions (as already noted this was not possible due to unusually hot weather for the period of the experiment). Table 40 gives the data for this experiment. Applying the fertilizer with the seed had a depressing effect on the speed of germination as in every case there were fewer seedlings in these boxes after 7 days than there were in the corresponding check and surface application of fertilizer treatments. This depression in speed of germination when the fertilizer was applied with the seed was very much greater and more obvious with the heavy application of fertilizer--500 pounds per acre; the ammonium phosphate (16-20) had a slightly greater effect in this direction than the ammonium sulphate (see Plate 1). As can be seen by examination of the third column of data (table 40) none of these fertilizer treatments had a detrimental effect on total germination in this experiment. The retarding effect of the heavy applications of fertilizer in contact with the seed was still evident 13 days after the seeds were sown; this can be seen by examination of the column giving total weight of seedlings for each box on the thirteenth day (table 40).

Unfortunately this experiment was carried out under

conditions greatly different from normal germination conditions. The temperatures for the period of the experiment were very high (see table 41)--this would tend to speed up the rate of germination; as a result it seems probable that the effects of the fertilizers on germination would be reduced since there would be a shorter time for them to act on the first tender, delicate root hairs and root systems. It may be argued that the high temperatures would also speed up the rate of chemical reaction so that the fertilizers would have a greater effect on the young root systems. However, the higher temperatures would probably accelerate the rate of germination more than they would accelerate the rate of chemical reaction. The high temperatures necessitated such frequent and heavy watering that the fertilizers probably were distributed much more completely and uniformly throughout the soil mass than they would have been with lower temperatures; this would reduce the concentration of fertilizer in contact with the first part of the root system and this too would probably reduce the effect of the fertilizers on germination.

Ammonium sulphate and ammonium phosphate (16-20) fertilizers applied with the seed at rates of 100 pounds and 500 pounds per acre had a depressing effect on the rate of germination of barley in peat but did not adversely affect total germination; similar applications on the surface of peat soil with barley seeded in it did not affect germination. In mineral soil ammonium phosphate at the 500 pounds per acre rate gave the same type of results as it gave in peat soil when applied at this rate. It is probable that the results

of this experiment might have been quite different if it had been carried out under conditions more like those prevailing in the spring when seeding of grain is ordinarily done.

Table 37

Germination counts for pot culture experiment with Peatland barley using Stony Plain and Duffield peats - 1940

These counts indicate the number of seedlings which developed from the twelve seeds seeded in each crock

Stony Plain			Duffield			Fertilizing elements
12	11	12	12	12	12	none
12	9	12	12	9	12	B
11	12	10	12	11	11	Mn
12	11	12	12	9	12	Cu
10	10	12	12	12	12	Zn
11	11	11	12	11	11	B + NPK
10	10	12	11	10	12	Mn + NPK
11	12	12	10	12	11	Cu + NPK
12	11	10	10	10	11	Zn + NPK

Complete NPK (9-27-9) fertilizer applied at the rate of 1250 pounds per acre

Table 38

Germination counts for pot culture experiment with Peatland barley using Stony Plain and Duffield peats - 1941

These counts indicate the number of seedlings which developed from the twelve seeds seeded in each crock

Stony Plain			Duffield			Fertilizing elements
12	12	12	12	12	12	none
12	12	12	12	11	11	B
11	12	12	12	12	11	Mn
12	12	12	12	12	10	Cu
12	11	12	12	12	10	Zn
11	12	11	11	12	12	NPK
11	11	10	11	11	12	B + NPK
11	11	12	11	11	10	Mn + NPK
12	10	12	12	11	11	Cu + NPK
12	11	11	12	11	12	Zn + NPK
10	12	9	11	12	12	NPK (9-27-9)

Complete NPK fertilizer (1 gm. potassium sulphate 2 gms. ammonium phosphate (16-20) except where 9-27-9 used) applied at rate of 1250 pounds per acre.

Table 39

Arrangement of experiment to determine the effects of fertilizers on barley germination in peat soil. July, 1941.

Checks	Surface fertilized	Fertilizer with seed	Original moisture condition
with ammonium sulphate fertilizer			
1	100 lb. per acre 2	100 lb. per acre 3	moist soil
4	100 lb. per acre 5	100 lb. per acre 6	wet soil
7	500 lb. per acre 8	500 lb. per acre 9	moist soil
10	500 lb. per acre 11	500 lb. per acre 12	wet soil
with ammonium phosphate (16-20) fertilizer			
13	100 lb. per acre 14	100 lb. per acre 15	moist soil
16	100 lb. per acre 17	100 lb. per acre 18	wet soil
19	500 lb. per acre 20	500 lb. per acre 21	moist soil
22	500 lb. per acre 23	500 lb. per acre 24	wet soil
with ammonium phosphate (16-20) fertilizer and mineral soil			
25	500 lb. per acre 26	500 lb. per acre 27	moist soil

Numbers in lower left corners are box numbers.

Table 40

Count and weight of seedlings in experiment to determine the effects of fertilizers on germination of Peatland barley in peat soil. July 8, 1941.

In boxes 1 - 9 and 25 - 27, 480 seeds were seeded. In boxes 10 - 24, 360 seeds were seeded.

Box no.	Count after 7 days	Count after 9 days	Count after 13 days	Weight of seedlings after 13 days	Fertilizer rate in lb. per acre	Position of fertilizer
			with ammonium sulphate fertilizer			
1	425	429	437	58.0	none	
2	440	445	449	54.5	100	surface
3	415	416	422	52.0	100	with seed
4	434	435	442	58.0	none	
6	423	412	421	64.0	100	with seed
7	441	450	452	56.0	none	
8	441	446	447	54.0	500	surface
9	250	391	421	33.0	500	with seed
10	328	334	336	39.5	none	
11	328	331	336	57.5	500	surface
12	290	335	337	44.0	500	with seed
			with ammonium phosphate (16-20) fertilizer			
13	316	321	321	42.0	none	
14	327	333	335	52.5	100	surface
15	307	330	331	40.0	100	with seed
16	328	333	336	50.0	none	
17	330	334	336	56.5	100	surface
18	319	326	328	51.5	100	with seed
19	315	328	342	40.5	none	
20	308	312	307	45.5	500	surface
21	87	304	324	32.0	500	with seed
22	319	320	329	50.5	none	
23	324	329	333	60.5	500	surface
24	144	295	306	40.0	500	with seed
			with ammonium phosphate and mineral soil			
25	438	444	445	17.5	none	
26	434	441	441	20.7	500	surface
27	310	441	452	19.3	500	with seed

Table 41

Temperature record for the duration of germination experiment, July 8 - 22, 1941

Date	Max. °F.	Min. °F.
July 8	72	47
" 9	65	50
" 10	73	52
" 11	80	50
" 12	80	50
" 13	82	50
" 14	84	59
" 15	91	56
" 16	95	61
" 17	95	60
" 18	97	61
" 19	88	62
" 20	87	61
" 21	76	57
" 22	73	52

PLATE I

(Pictures taken one week after seeding of germination experiment.)

These pictures show how germination of Peatland barley is retarded when fertilizers are applied with the seed at the rate of 500 pounds to the acre.

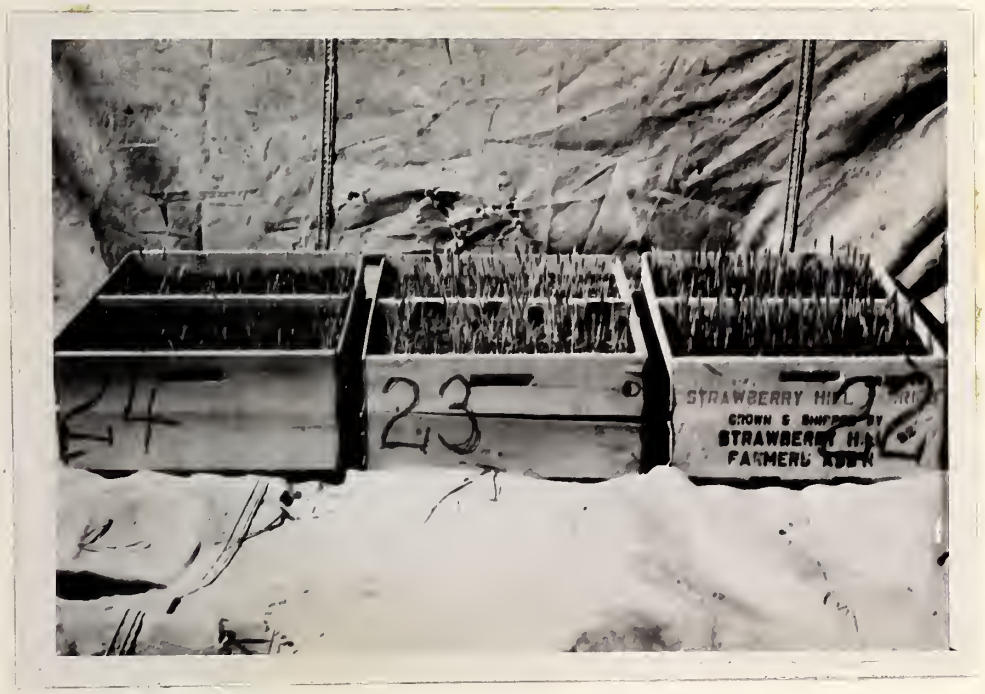
In each picture the box on the left had fertilizer applied with the seed; the box in the centre had the same amount of fertilizer applied on the surface of the soil after the seed was covered; the box on the right is an untreated check. Boxes in picture A contain mineral soil; the other boxes all contain peat soil.

Ammonium phosphate (16-20) at 500 pounds to the acre was used in boxes shown in pictures A, B and C.

Ammonium sulphate at 500 pounds to the acre was used in boxes shown in pictures D and E.

-A-

PLATE I (cont'd.)



-B-

-C-

PLATE I (cont'd.)

-D-

-E-

SUMMARY

The results of field plot experiments, pot culture experiments, nitrate determinations, chemical analyses and a germination experiment, with Alberta peat soils have been reported. The following results were obtained in these experiments:

I. In field plot experiments with barley on peat soils:

(1) Of the various fertilizers used a complete N+P+K fertilizer was the only one which gave relatively consistent increases in yield of grain + straw and in yield of grain.

(2) With Peatland barley the N+P treatment gave relatively consistent increases in yield of grain + straw but the yield of grain alone was lower than that of the check.

(3) The fertilizers containing nitrogen usually increased the nitrogen content of the grain from those plots.

(4) Fertilizers containing phosphorus increased the phosphorus content of the grain from those plots in all cases reported except two; in these two cases the phosphorus content of the grain was much higher than it was in the other cases reported.

II. In pot culture experiments using peat soils:

(1) In Stony Plain peat which is low in total potas-

sium it was found that Na_2SO_4 could partly replace K_2SO_4.

(2) In general the treatments of N+P+K and N+P+Na gave increases in yield of grain and in yield of grain + straw when compared with the check.

(3) Large differences were found in potassium and sulphur content of straw from the various treatments. Usually pots treated with N+P, and N+P+Na were lower than the check in potassium content of straw; the N+P+K treatment gave straw higher than the check in potassium content. Sodium sulphate usually increased the sulphur content of straw more than K_2SO_4 and the check was usually lower than the N+P, the N+P+Na (Na_2SO_4) and the N+P+K (K_2SO_4) treatments in sulphur content of straw.

(4) In one case copper, a "trace" element, was shown to give a slightly better yield of grain + straw than treatments of boron and manganese when these elements were applied with a complete N+P+K fertilizer. In the same experiment zinc gave a slightly better yield of grain + straw than the boron gave.

III. The two peats which were analyzed chemically have at least an average supply of some of the commoner essential elements when compared with other peats in North America and Europe.

IV. Nitrates in Stony Plain and Duffield peats fluctuated considerably and were not correlated with fertilizer treatments. Nitrates were much higher in Duffield peat.

V. Ammonium phosphate and ammonium sulphate, under conditions of an experiment reported, were found to slow up germination of Peatland barley when applied with the seed in peat soil; there was no ultimate reduction in percent germination due to these fertilizers applied in this way. In pot culture work a N+P+K fertilizer at the rate of 1250 pounds per acre had a detrimental effect on the percentage germination.

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